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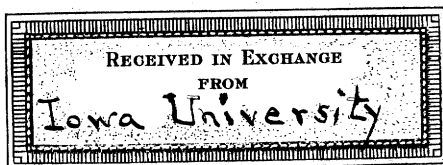
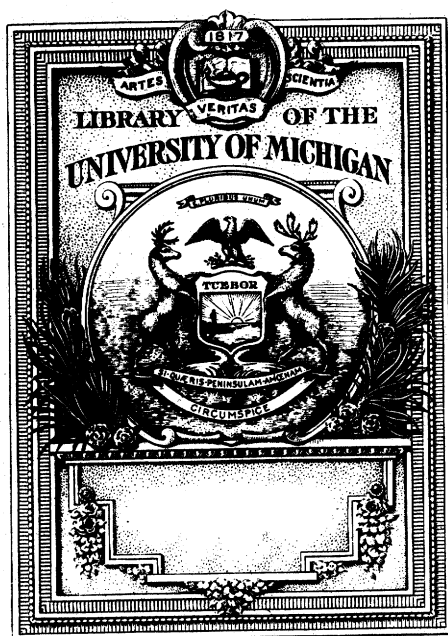
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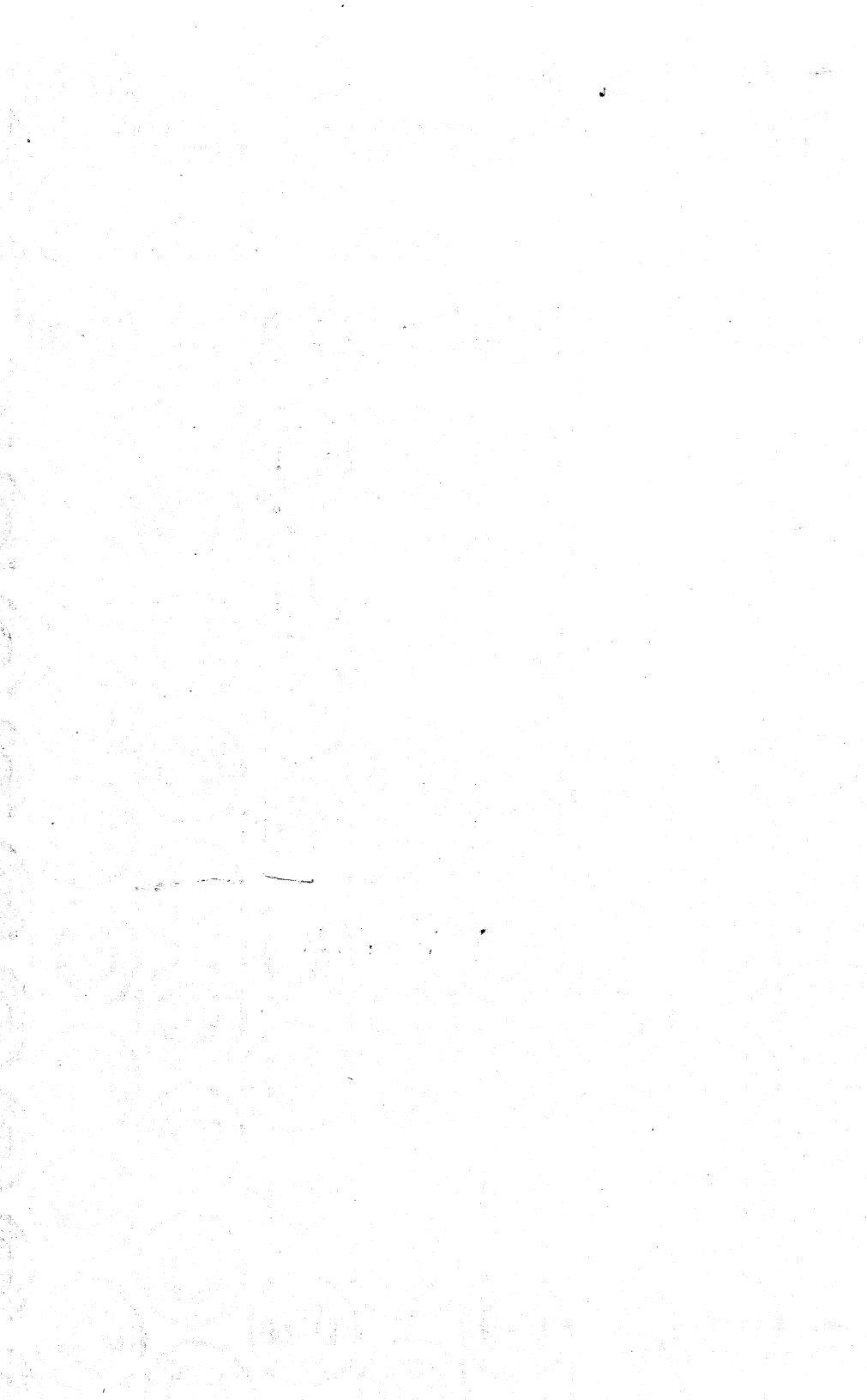
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Continuation of Bulletin from the Laboratories of Natural History
of the State University of Iowa

VOLUME VIII

NUMBER 1

THE ANIMAL ECOLOGY OF JOHNSON COUNTY

BY

DANIEL MILTON BRUMFIEL

PUBLISHED BY THE UNIVERSITY, IOWA CITY

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THE ANIMAL ECOLOGY OF
JOHNSON COUNTY

A preliminary survey of the major animal
habitats of Johnson County, Iowa
with an atlas

BY
DANIEL MILTON BRUMFIEL, PH.D.

PUBLISHED BY THE UNIVERSITY, IOWA CITY
February, 1919

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D. M. B.

I

INTRODUCTION

This paper has assumed its present title and form from the necessity of conforming to the first needs of investigation concerning the ecological relations of the animals in the region with which it deals. The original intention of the writer was to analyze briefly the chief animal habitats afforded by Johnson County and to carry on a series of intensive studies of the animals forming the various associations in these respective habitats with the hopes of drawing some large conclusions as to the reactions and interrelations of such groups of animals. This plan was discontinued in favor of the one upon which this paper is now based for the following reasons: (1) the lack of definite information as to the location of particular habitats, their extent, accessibility, etc., from which to carry on such investigation; (2) the immediate necessity of compiling and placing on record available information in accessible form as a nucleus for future intensive studies; (3) the urgent desirability of having a descriptive atlas bearing this information of the country immediately surrounding the University of Iowa for the use of workers in this institution; and (4) the wish to make a typical survey and atlas of one county of the state as a precedent for work in other localities.

This paper is further intended to bring together all of the data pertaining to this region, such as topography and climate, that shall be pertinent to any interpretative studies of the animal life. Emphasis, therefore, is laid upon the habitat rather than upon the fauna, and all attempts at detailed discussion of the various animal associations have been omitted. Numerous references are made to the animal life throughout the text, but care has been taken to keep these in the form of general statements, in order to prevent diversion of the emphasis of the treatise. For this same reason the scientific names of species have not been given.

II

METHODS

The survey and mapping of the habitats was carried on by townships. In the absence of outline maps of the separate townships, it was found necessary to make a copy of each on tracing cloth. These copies were based on an atlas of Johnson County* with such modifications as were patent from the work in the field. Each tracing was used to make a number of blueprints, on the scale of two inches to the mile, which were directly utilized in the field.

Each blueprint for field use was cut into strips, approximately four inches wide, and mounted on heavy cardboard of the same width. The cardboard provided the necessary stiffness for writing and was found useful for the inscription of notes in addition to the areas sketched on the map itself. These strips were of a most convenient size for slipping into the pocket and enabled the investigator to carry the map of the particular part of the township upon which he was then working without being encumbered with the whole map.

Accomplishment of this work in the amount of time available was possible only through the use of some rapid and dependable means of transportation, as the thorough mapping of some six hundred square miles of territory requires many hundred miles of travel along the roadways. This difficulty was met by the utilization of a Ford roadster. This machine, with its cyclometer, and a compass and pedometer in the pockets of the writer, enabled him to locate and estimate the size, direction, and extent of each habitat formation upon the maps with sufficient definiteness to make each grove, thicket, pond, or bog quite easily found and distinguished by a stranger using the atlas.

The analysis is the result of a series of field excursions over the county from September, 1913, to July, 1917.

**Atlas of Johnson County, Iowa.* Huebinger Survey and Map Publishing Company, Davenport, Iowa, 1900.

III

GENERAL FEATURES OF REGION

Johnson County, Iowa, may be located geographically by its county seat, Iowa City, which has a latitude of $41^{\circ} 40'$ and a longitude of $91^{\circ} 31' 30''$. In United States land surveys, Johnson County is included in townships 77-81 north and ranges 5-8 west of the principal meridian. It contains approximately 618 square miles in extent and consists of a square of 24 by 24 miles, to which is appended an additional township on the southeast corner. This southeast township, Fremont, is six miles in its north and south dimensions and averages seven miles in width east and west. Its east boundary is continuous with the east boundary of the rest of the county, and its west edge is bounded by the southward wanderings of the Iowa River.

GEOLOGY

As Calvin pointed out,* except for certain local outcroppings of rock of the various strata of the Paleozoic age, the surface formations of Johnson County had their origins in the Glacial and Postglacial epochs. These outcroppings are, with rare exceptions, bluffs adjacent to the Iowa River and certain of its tributaries, more especially to those entering it from the north and east.

The remainder of the surface has been formed of the glacial drifts of the Kansas and Iowa ice sheets, which in turn have been overlain with loess except for a naked lobe of Iowa drift extending a few miles into the county from the northwest. Through and upon these, the larger streams have established their flood plains, which in the upper and lower parts of the county are of considerable width. Plate I is an adaptation of Calvin's map of the surface deposits, modified to show only the surface or soil areas. The hatched areas indicate the naked lobes of the Iowa drift; the stippling represents alluvium deposit, and the plain sections indicate the deposits of loess upon underlying glacial drift.

Johnson County is peculiar in that the highland lies for the

*Calvin, 'Geology of Johnson County,' *Annual Report of Iowa Geological Survey*, VII (1897), pp. 33-116.

most part in rocky bluffs along the rivers through which the latter have cut their course, apparently going out of their way to avoid the more extensive, more easily occupied, and relatively uniform loess prairie land at the side. This peculiarity is accounted for by the indications that the Iowa River now follows in general an interglacial valley, which was probably 150 feet greater in depth than the one which it now occupies.

TOPOGRAPHY

Johnson County presents but little range in altitude, the variations being but from approximately 665 to 800 feet above sea level. This variation is evident in the immediate vicinity of the Iowa River north of Iowa City for some fifteen miles. Throughout this region the river valley is narrow, having been cut through the elevated rock formations; its valley walls rise abruptly in many places in the form of bluffs, the tops of which may be a hundred feet above the river bed.

From the entrance of the stream into the county to the point where it passes into the narrow, bluff-confined portion of its valley, in Section 22, Township 81 north, Range 7 west, only one side of the valley is abrupt, the north. Likewise, although to a less pronounced extent, below Iowa City the west slope of its valley is more abrupt than the east slope.

Plate II is a photographic reproduction of those portions of the county which have been topographically surveyed by the United States Geological Survey. It was obtained by piecing together those parts of Johnson County contained in the Amana, Oxford, Cedar Rapids, Mechanicsville, and West Liberty topographical map sheets.* This plate shows the topography, in twenty-foot contour lines, of all the county except the lower thirty-six sections of Fremont township, of which no survey has been made to date. As shown by this map, the rough land lies for a few miles on each side of the Iowa River from Iowa City north to the abrupt bend in that stream in Section 22, Township 81, Range 7 west, continuing along the north edge of the valley through Jefferson and Monroe townships to the edge of the

*Topographical Maps, published by the United States Geological Survey in cooperation with the Iowa Geological Survey, Des Moines, Iowa. Cedar Rapids, Mechanicsville, Iowa City, and West Liberty sheets were surveyed in 1887, Amana and Oxford sheets, in 1888.

county and spreading to the northeast to include Newport and much of Big Grove townships. Portions of Cedar, Graham, and Scott, as well as the southern edge of the Clear Creek and Old Man's Creek valleys in Clear Creek, Union, Liberty, Sharon, and Washington townships are also too rough for purposes of cultivation. These areas will be more fully treated under the discussion of the forest habitats.

LAKE BASINS

Remnants of a number of ponds and small lakes may be found in the upper half of Madison township. The largest of these, Swan Lake, is still nearly half a mile in its largest dimension, although it is now little more than a swamp, having been filled in by materials carried by rain-wash and by the addition of organic matter from the annual death and decay of the many plants which flourish in it. Calvin states that at the time of the coming of the first settlers, this was a "beautiful little sheet of clear water, twelve to fifteen feet in depth, and well stocked with fish." Many of the smaller ponds and lakelets of this region have become completely obliterated, although traces of a few still remain. Several of the larger ones are indicated on the topographical map which was made thirty years ago. According to Calvin, these depressions are kettle holes in the drift plain along the line where the drift plain and alluvium merge into one continuous surface; and it is probable that all of these depressions had the same origin and were due to the final melting of detached ice masses which formed a part of the glacial debris.

DRAINAGE

Johnson County is drained by one master stream, the Iowa River, with certain smaller areas taken care of by the Cedar River and the English River. The latter, however, is a tributary of the Iowa and empties into that stream just outside the county, in fact just opposite the second tier of sections in Fremont township. The watersheds of these areas are indicated on the topographical map (Plate II) by a broken line.

The Cedar River drains a small portion of the northeast corner of the county, and that stream itself has a course of a few miles across the corner of the county. Its basin here comprises a large

part of Cedar township and a very narrow strip of Graham township adjoining on the south. Again, the Cedar receives the drainage of an irregular strip of land including a few sections in the southeast corner of Graham township and approximately the east half of Scott township and the northeast half of Lincoln township.

The area drained by the English River is that of the Deer Creek basin in Washington township. This Deer Creek basin covers approximately the southern three-fourths of the township and the run-off has a general southerly direction.

As to the remainder of the county by far the larger area is drained by the Iowa River. This stream enters the county between Monroe and Oxford townships, in Section 31, Township 81 north, Range 8 west, and continues with many windings in an easterly direction to the point where it enters the narrow, bluff-confined portion of its valley at Section 22, Township 81 north, Range 7 west. From this point it swings to the south and follows many tortuous but constant loops, bending to the southward until it leaves the county. Below Iowa City its valley again widens and its meanderings become variable. It leaves the county at Section 32, Township 71 north, Range 5 west, having within the last few miles swung around toward the southeast, and holding this direction until it reaches the Mississippi, some thirty miles distant.

Within the county the Iowa River receives only two noteworthy tributaries from the west, Clear Creek and Old Man's Creek, with a smaller intermittent stream,* Pardieu Creek, the basin of which lies almost wholly in Penn township. Clear Creek has its origin outside the county and drains the southern two-thirds of Oxford, all of Clear Creek, and the northwest corner of Lucas townships. The low-lying, sandy northern third of Oxford township and practically all of Madison township, which is similar, are drained by a number of small intermittent brooks, which run directly to the river. Except a few small streams which empty into the river itself, the remainder of the county west of the river is drained by Old Man's Creek and its tributaries. The Old Man's Creek basin includes all of Hardin,

*Incorrectly labelled Muddy Face Creek on the Map of Penn township, Plate XI.

Union, and Sharon townships, together with the north part of Washington, the southwest corner of Lucas, and all of Liberty save the southern eight sections.

From the north and east the Iowa River receives the run-off by means of a number of small streams, several of which are of sufficient size and constancy to have been given names. The first is known as Knapp Creek, which has its origin just outside the northwest corner in Linn County and drains the most of Monroe township. McAllister Creek also has its origin in Linn County and flows through Jefferson township, emptying into the river about seven miles below the mouth of Knapp Creek. Lingley's Creek, the next in order, drains the northeast third of Jefferson and the northern half of Big Grove townships. A short distance below are found Mill Creek and Jordan Creek, which unite within a half mile of their confluence with the river. These creeks drain the west edge of Cedar and the south half of Big Grove townships as well. Below these are two very short streams known as Silver's Creek and Mud Creek respectively. Their basins lie wholly within the northwest portion of Newport township, the rest of which is drained by Turkey Creek, Saunder's Creek, and Rapid Creek. Saunder's Creek is really a tributary of Rapid Creek, as it joins the larger stream about a mile from its mouth. Rapid Creek is the largest tributary of the Iowa River within the county from the east or north. It rises near the east edge of the county in Graham township, which it drains before entering Newport township. Ralston Creek drains the northern part of East Lucas township and wanders in its course through Iowa City, emptying its water into the Iowa at the south boundary of the corporate limits. Snyder Creek drains the west half of Scott township and crosses the southeast corner of East Lucas and the northwest corner of Pleasant Valley townships on its way to the river. Below this Buck Creek and Otter Creek drain the west half of Lincoln and the lower part of Pleasant Valley townships. Fremont township, low-lying, level, and of a general sandy nature, is drained by a number of intermittent streams not herein named.

SOIL

Soil, except for its physical characteristics, is not a primary factor in determining animal habitats. It must be admitted, however, that such physical characteristics as are represented by alluvial loam, gravel bars, or rocky bluffs, limit the components of the animal associations to certain forms whose adaptations fit them to meet with the physical conditions of the environment. Yet animals primarily depend upon the vegetation rather than the soil as a distribution control, and as Shimek* has pointed out, such vegetational features as prairie and forest are influenced little by soil composition. The main types of soil for this county are shown on the map comprising Figure I, to which reference has already been made.

RAINFALL AND CLIMATE

The conditions of rainfall and climate are best and most tersely expressed in the table of climatological data which is here given. These figures are based upon careful observations, made in connection with the United States Weather Bureau.† These averages may be taken as representative, as they are drawn from daily records made during a period of twenty years. The average rainfall is computed from this table to be 33.82 inches. The minimum annual rainfall for the driest year of the twenty from, 1896 to 1916 was 22.32 in 1910; the maximum was 47.80 in 1902.

The most fairly representative variation in temperature throughout the year may be deduced by subtracting the lowest monthly average absolute minimum temperature from the highest monthly average absolute maximum temperature. This gives -15.6° to be subtracted from 97.7° , leaving an annual average variation in temperature of 113.3° . The columns giving the average mean maximum and average mean minimum temperatures may be interpreted as representing the optimum conditions for the existence of our native animals, or those temper-

*Shimek, "The Prairies," *Bulletin from the Laboratories of Natural History of the State University of Iowa*, Volume VI, Number 2, pp. 169-240; 14 plates including state map with prairies and forested areas.

†1896 to October 1905, by A. A. Veblen; November 1905 to August 1909, by Karl E. Guthe; September 1909 to October 1916, by A. G. Smith; since October 1916 by J. F. Reilly. These data were published regularly in *Climatological Data*, Iowa Section, in coöperation with the Iowa Weather and Crop Service, U. S. Department of Agriculture, Weather Bureau Office, Des Moines, Iowa.

TABLE OF CLIMATOLOGICAL DATA FOR IOWA CITY, IOWA, FOR A PERIOD OF
TWENTY YEARS

Month	Av. Mean Max.	Av. Mean Min.	Av. Mean	Av. Ab. Max.	Av. Ab. Min.	Av. Prec.	Low Ext. Mean Max.	High Ext. Mean Max.	High Ext. Mean Min.	Ext. Ab. Max.	Ext. Ab. Min.	Ext. Max. Prec.	Ext. Min. Prec.
Jan.	30.7	10.4	18.9	50.4	-15.6	1.63	13.1	36.3	17.9	64.0	-30.0	4.62	.26
Feb.	30.4	9.7	20.9	52.4	-14.0	1.55	22.8	37.1	18.2	63.0	*32.0	4.82	.22
Mar.	46.8	26.6	36.7	72.0	7.3	2.22	34.3	61.4	31.8	87.0	-11.0	3.62	.28
Apr.	60.5	36.7	49.5	83.0	23.0	3.37	54.1	65.6	40.7	90.0	13.0	7.21	1.58
May	72.1	48.9	60.8	88.0	33.0	4.64	64.8	78.2	54.4	95.0	24.0	9.49	1.54
June	81.5	57.8	70.2	94.0	45.0	3.58	76.2	87.1	61.3	102.0	37.0	8.29	.98
July	87.1	62.0	74.4	97.7	50.0	4.58	82.2	97.9	59.1	*108.0	43.0	10.10	.90
Aug.	85.4	60.3	72.9	97.0	48.0	3.65	80.9	91.8	55.5	100.0	41.0	10.91	.66
Sept.	77.5	52.8	65.2	93.0	35.0	3.00	70.9	85.7	48.0	101.0	20.0	7.97	.89
Oct.	65.6	40.4	52.8	84.0	23.0	2.18	58.1	73.1	34.8	91.0	10.0	5.36	.33
Nov.	48.1	25.8	36.8	70.0	8.0	1.82	39.4	62.0	19.3	81.0	-6.0	4.88	.25
Dec.	33.7	15.3	23.6	53.0	-7.4	1.60	23.8	43.2	6.0	66.0	-18.0	2.84	.43
Average annual precipitation 33.82													*1901
													*1905

ature conditions under which they thrive best. The columns showing extreme mean temperatures may likewise be taken as giving the limits beyond which these forms do not successfully maintain themselves.

FLORAL CHARACTERISTICS

In general, the floral characteristics of this county fall into two large classes, *forest* and *prairie*. In its original undisturbed condition a band of timber extended along the main water courses and was very generally distributed over the roughest of the land to each side.* The remainder of the county was prairie. In the bottom land, the native timber was chiefly elm, mixed with cotton-wood, birch, willow, etc., while on the upland and the rough land, even when quite near the streams, the forest was composed primarily of oak, frequently mixed with hickory and often found in conjunction with hazelnut, particularly if the oak be scattered.

The relation of the forested areas to the rough land may be seen by comparing the topographical map (Plate II) with the several township maps which indicate the present distribution of timber. From this it will be at once deduced that the rough land only, at any distance from the larger streams, provides conditions favorable for the maintenance of forest. From this it is at once seen that the present forested areas are only in the rougher parts of the county, namely the rocky bluffs along the Iowa River north of Iowa City, all of Newport township, the south half of Big Grove, Jefferson, and Monroe townships, and parts of Graham and Cedar townships. In addition to these, the most important strips of timber lie along the valleys of Clear Creek and Old Man's Creek with scattered areas throughout Washington, Sharon, and Liberty townships. It is a significant fact that the distribution of trees along the creek valleys just noted is mainly on the south and more abrupt slope of the valley in each case. In other words, native trees, and hence forest, have been able to establish and maintain themselves only on those areas on which they were afforded protection from evaporating forces. This bears out Professor Shimek's conclusions† regard-

*B. Shimek, from certain unpublished data.

†The Prairies, B. Shimek; page 230.

ing the causes of the treelessness of the prairie, which are here quoted because of the light which they throw upon an understanding of both the forest and the prairie of this region :

"1. Exposure to evaporation as determined by temperature, wind, and topography, is the primary cause of treelessness of the prairies.

"2. The prairie flora persists on the exposed areas because it is xerophytic.

"3. Rainfall and drainage, while of importance, because determining the available supply of water in both soil and air, are not a general determining cause, both being frequently equal on contiguous forested and prairie areas.

"4. Soils and geological formations are of value only in so far as they affect conservation of water; the porosity of the former determining its power of holding moisture, and the latter often determining topography.

"5. Prairie fires were an effect rather than a cause, and where acting as a cause were local.

"6. Seed-dispersal probably accounts largely for the grouping of plant societies on the prairies, but does not account for the presence of the prairie as a whole.

"7. Other assumed causes, such as the bison, sea, etc., are of remote interest and not to be taken into account in any attempt at an explanation of the prairie as a whole."

The foregoing quotation serves to explain the occurrence of the prairie on all land not forested, in the original conditions. As the reduction of this great area of prairie to a few narrow strips is discussed under the heading of prairie habitats, it will be merely mentioned here. The composition of the prairie, however, merits some consideration at this point. In his classification of the prairies Shimek* refers to three types as having been existent in Johnson County: the *rolling prairie*, the *alluvial prairie*, and *prairie openings* in the forested areas. Of these, however, the present consideration need not deal separately, as the most typical xerophytic plants which compose them are general. The prairie plants represent a high type of plant specialization, the larger percentage of species being members of the family *compositae*. In number of individuals the grasses and

*Shimek, *The Prairies*, p. 174

sedges perhaps out-do the composites. Following upon these in ever decreasing numbers of species and individuals are the Leguminosae, Liliaceae, etc.

GENERAL FAUNAL CHARACTERISTICS

With reference to its fauna, Johnson County is located in the Upper Austral Zone,* as is most of the state of Iowa, the exception being a narrow strip in the north part just below the Minnesota line, which is in the Transitional Zone. The Upper Austral is divided into the Carolinian Faunal Area and the Upper Sonoran Area, Iowa falling into the Carolinian Area except for the small strip mentioned above. This is the area of the greater part of the middle states, and in it are found both the grey and the fox squirrel.

Johnson County, in particular, representing as it does an interdigitation of the forest and prairie, naturally affords a mingling of habitats suitable for the animals of both types of environment. Thus we may expect to find within a few rods of each other such typically forest forms as the grey and fox squirrels, and such typically prairie forms as the 13-lined spermophile and the common bull snake.

*Merriam, 'Life zones and crop zones of the United States, *Bulletin No. 10*, U. S. Department of Agriculture, Division of Biological Survey, 1898, pp. 1-79.

IV

ANALYSIS OF THE MAJOR ANIMAL HABITATS

The purpose of this paper is to analyze only the animal habitats unaffected by man, or those which have remained in a comparatively unaffected state. For that reason no attempt has been made to classify cultivated or pasture lands, save in those cases of the latter where indigenous forest trees are present. For this same reason all discussion and mapping of groves planted as windbreaks have been omitted, although the establishment of animal associations in such groves offers some interesting problems for the ecologist.

For the purpose of logical consideration the animal habitats of Johnson County will be discussed under two main headings: (1) *terrestrial*, and (2) *aquatic*. A third, which is really a minor heading, is transitional. This last will be discussed in connection with aquatic habitats. An additional group of habitats will at once be suggested by some workers in this field, namely, the marginal zones where the terrestrial and aquatic conditions meet. By this we have in mind those habitats peculiar to the banks of streams, in contrast to the transitional habitats afforded by swamps and bogs. While these are unquestionably terrestrial from one point of view, in that they are upon the land, yet inasmuch as they are always the result of the most recent action of the stream, they will be discussed in connection with aquatic formations.

TERRESTRIAL HABITATS

As already indicated, the terrestrial habitats yield to a ready division into two groups, (1) prairie and (2) forest. A subsidiary series of habitats must also be recognized, that of the marginal zone between forest and prairie, which, possessing some of the characters and forms of both, is identical with neither and, belonging definitely to neither, is a part of both.

THE PRAIRIE HABITATS

Originally, before the claiming of Johnson County for agricultural purposes and the complete cultivation of the tillable land, this was a typically prairie region, save in the relatively narrow strip of timber in the rough land along the watercourses and on the flood plains. This prairie ranged in character from that of the semi-arid sand dunes of the west part of Madison township and the north part of Oxford township, which were, and are, decidedly xerophytic in nature, through the various stages of the open prairie approaching the mesophytic in the bogs and swamps, where the vegetation shaded gradually into the hydrophytic.

Of these original prairie conditions but little remains. This has, of course, been due to the fact that the open rolling and alluvial prairies afforded the best opportunities for farming. Consequently these stretches of land were rapidly put under cultivation until only a few limited areas remain to evidence the true character of the prairie itself. These limited areas have been accidentally preserved on certain of the earlier railroad right-of-ways. The more extensive of these strips is that lying along the Chicago, Rock Island and Pacific right-of-way, which reaches from within the city limits of Iowa City eastward for several miles. The largest remaining bit of prairie, except a very small patch within the city limits near Black Springs, is a small stretch of sandy prairie just outside the city along the track of the Chicago, Rock Island and Pacific Railway south of Iowa City.

Of other types of prairie formation practically nothing remains in the original condition on account of cultivation and persistent pasturage of the less tillable land. While formerly the forested areas north of Iowa City contained many bits of open prairies, or "oak openings" on the hilltops, which were too much exposed for the establishment of forest, these too have been pastured until they no longer present the original natural vegetation. These small strips of "once-prairie" are still recognizable by the absence or scarcity of trees, and by the presence of the 13-lined spermophile, which has persisted on these open spaces but is not regularly found in the adjacent timber.

Even the two remaining strips of typical prairie cited (indicated by x-shaped marks upon the county map, Plate III*) are so limited in extent that the animal life is no longer truly representative in character. An apparent exception to this statement may be presented, viz., that the invertebrate forms, chiefly the insects, remain as they were originally, owing to the fact that the same plants are present in species and numbers comparable to former conditions. Yet changes have been brought about in the vertebrate fauna, and even in the insect fauna, due to the establishment of introduced forms from the adjacent cultivated fields, so that the present conditions are not identical with those of previous times. However, these bits of prairie are the most representative of any in the county, and careful intensive studies of the animal associations now occupying them should contribute something of value toward an interpretation of the groupings of animals that once held place.

The rolling prairies. This type of prairie was the one which originally covered the greater part of the county and is still represented by the strip of land along the Chicago, Rock Island and Pacific railroad east of Iowa City. This is directly upon the loess deposits, which accounts for the rolling topography. It was established over all the loess deposits in the county except those areas which were forested. Its topography makes for rapid drainage after rainfall. This, together with the fact that it is fully exposed to all the evaporating effects of wind and sun and all changes of temperature, has made it impossible for any but plants xerophytically adapted to maintain themselves. The soil is loose and fertile, permitting a great abundance of plants fitted to cope with the conditions. Thus the great majority of plants making up its vegetation are composites and grasses. This multiplicity of plant species has made possible the existence of a great variety of insects; and the occurrence of the flowering, highly specialized composites accounts for the great abundance and variety of the insects of the more highly specialized orders—the Hymenoptera, Diptera, Lepidoptera, and Coleoptera, many, indeed, of which are nectar-feeding or pollen-carrying forms. These prairie plants, while all are modified in some way to meet

*Adapted from the *Good roads map of Johnson County*, copyright by M. Huebinger, 1913.

conditions of drouth either by the development of hairs, thickened epidermal layer, reduction of the number of stomata, reduction in the number or size of leaves, or a general dwarfing, provide fresh living tissue for innumerable leaf and plant-juice feeders such as the larvae of Lepidoptera and Coleoptera and the Hemiptera. All these in turn permit the existence of a great variety of parasitic and predaceous forms. The relatively tender plants of summer with their seeds for winter consumption, together with the fact that the loose soil made easy the construction of burrows, summoned the gopher, Franklin's ground squirrel, and the 13-lined spermophile into the already complex animal association. The abundant insect life makes a paradise for such birds as the meadow lark and the dickcissel.

Alluvial prairie. The alluvial prairie is represented mainly by the short stretch just south of Iowa City and it differs from the rolling prairie chiefly in topography and soil. The topography is inclined to be level rather than undulating and the soil is usually a very sandy loam. The spermophile prefers the higher slopes of the rolling prairie, but the dry land tortoise is here met much more frequently.

The prairie openings. The prairie openings or "oak openings," as has been stated, are no longer found in any degree sufficiently like their original condition to warrant a detailed treatment in an account of contemporaneous habitats.

The sand dune prairies. Attention has already been called to the fact that these sand dunes possess certain characters which serve to differentiate them from the surrounding territory and thus create conditions favorable for a different set of animal associations.

These dunes have been built of shifting sands, and in one or two instances this shifting is still going on. Dunes which are under cultivation have not been considered, and only those were mapped which are practically barren at their summits. The barrenness is due, of course, to their extreme aridity. This is accounted for by their inability to retain moisture through their physical nature and also to the fact that they are thoroughly exposed to the evaporating forces of extremity of temperature, and particularly that of the hot southwest winds of late summer.

The plants which have been able to establish themselves with any degree of permanence upon these summits are naturally the most xerophytic of all the prairie forms. Descending these dunes, from the summit toward the base, is a constant increase in the number of individuals and of species. A corresponding increase, therefore, in the number of animal forms and in the complexity of the animal associations in the same ratio is to be expected. This is the region of the greatest abundance of the land tortoise, whose tracks were visible on the dry sandy summit of every naked dune in April, 1917. Of the more common invertebrates, Tiger beetles and digger wasps command attention.

The location of these dunes is given on the County Map, Plate III. They are to be found at the areas indicated by Δ -shaped marks. It will be seen that their distribution is limited to the west part of Madison township and the north part of Oxford township. The one found in the southeast quarter of Section 12 of Oxford township is the best example in the county at present of a shifting dune. A similar semi-barren sand area in Penn township, Sections 29 and 30, Township 80 north, Range 6 west, is also given on this map. It is somewhat similar in reference to its physical characters and vegetation, although it is evidently of alluvial origin, and has been listed because of its availability from Iowa City as a working center.

FOREST HABITATS

The forested areas of Johnson County, while they are of much more limited extent than the original prairies and while they have been very much reduced and modified by man, present such a great number of varied conditions that they easily afford a life's work in any attempt to do justice to a proper intensive study of their animal associations. The tree-covered lands vary in character from steep, rocky bluffs to low-lying, semi-swamp-stretches on the alluvial plain. The trees themselves vary from the burr oak of the uplands to the willow and water birch along the sloughs and streams, which actually stand in water several weeks of the year. Between such extremes as these there are all stages of intergradation, all possible types of intermingling.

Any classification of these formations under a few headings is of necessity arbitrary and artificial. That which has been adopt-

ed here, although unsatisfactory in many respects, affords the best logical rough divisions from the viewpoint of the animal life. No attempt has been made to take into consideration all the species of trees, but the classification has been based upon the predominating species. Even this presents difficulties, particularly in the case of the oaks, of which there are some half dozen species common in the county. The oak formations vary from the burr oak and red oak common on the higher grounds to the mixture of swamp oak, pin oak, and shingle oak, respectively, among other trees on the low grounds of alluvial formation. While each of these several species must have its own particular parasites, yet the insect forms, such as borers, feed more or less indiscriminately upon all species of a single genus.

For the present purposes the forested lands have been classified as follows with reference to the predominating species: (1) oak; (2) oak-hickory; (3) elm (on the alluvial land of the larger streams usually mixed with cottonwood, box elder, soft maple, hawthorne, etc.); (4) willow; (5) hazel; (6) miscellaneous thickets; (7) cleared land on which the stumps remain. The extent and area of all these is shown upon the separate township maps, Plates IV to XXIII. Cross hatching, both horizontally and vertically, of any area indicates that there is abundant underbrush also present.

(1) *Oak*. As indicated in the general discussion, the oaks alone present a widely varying series of conditions, both as to distribution and as to species. Disregarding these factors in this preliminary survey, it has been considered necessary to make some further classification of the oak formations. Briefly, these are scattered oak groves, quite uniformly in pastures, oak timber free from underbrush (due also to pasturing), and oak timber with abundant underbrush. On the township maps, all oak has been represented by irregular O-shaped marks. The scattered characters indicate scattered oak, the characters upon horizontal ruling indicate oak timber, and when cross-ruled means oak timber with underbrush. As will be seen, for example in Section 31, Fremont township, the oak frequently merges into other formations. The O-shaped character in conjunction with solid black triangles indicates oak-hickory.

In treating the animal associations of such formations, Shelford* recognizes four strata of life: (a) *subterranean-ground stratum*, (b) *field stratum*, (c) *shrub stratum*, and (d) *tree stratum*. Adams,† in a similar consideration of the same subject, which he treats under the head of "communities," recognizes and discusses in detail six such divisions, as follows: (a) *forest soil community*, (b) *forest fungus community*, (c) *forest undergrowth community*, (d) *forest crown community*, (e) *tree-trunk community*, (f) *decaying wood community*. This analysis will follow the plan of the same six subdivisions of the forest habitat brought out in Adams' "communities" in so far as it is applicable to the various forest formations herein treated.

Scattered oak groves. The scattered oak groves occur for the most part on the uplands and usually are much more exposed to evaporating influences than any of the other forest formations. They are found regularly on hillsides, and not infrequently on slopes that show out-croppings of rock. The main distinguishing physical characters are excellent drainage, relatively low moisture content of the atmosphere, and abundant light in all parts (due to the scattered condition of the trees). Not all of such groves are absolutely natural, as conditions have frequently been created by the thinning out of the trees in an ordinary solid piece of oak or oak-hickory until but a few remain. As these are uniformly pastured, but little of the original vegetation has been preserved save the trees themselves. The surface of the ground has become set in a blue grass sod in which there is some intermingling of other grasses, a few composites, etc.

From the standpoint of the life strata, only the *soil communities*, the *tree-trunk communities*, and the *tree-crown community* need be considered. The lack of underbrush eliminates the *undergrowth community* and the comparative scarcity of fungi renders the *fungus community* of only occasional importance. The *decaying wood community* will deserve consideration only when the grove is the result of the thinning out of former solid

*Shelford, 'Animal communities in temperate America,' *Bulletin No. 5*, the Geographic Society of Chicago, University of Chicago Press, 1913; 362 pages, maps and plates.

†Adams, 'An ecological study of prairie and forest invertebrates,' *Bulletin of the Illinois State Laboratory of Natural History*, XI (1915), Article II, pp. 34-279; 63 plates.

timber. The *soil habitat* in this case will present an association of animals not essentially different from that of grass sod in general. The principal forms will be root-feeding forms of insect larvae, such as the white grubs and plant lice, while those on the surface will be caterpillars, herbaceous beetles, and plant bugs, accompanied by ground beetles and other predaceous forms. The *tree-trunks* provide homes and food for wood-borers, which with their parasites and the forms that prey upon them form an association. The *tree-crowns* with their mass of foliage provide for many leaf-eating insects, and thus prepare food as well as nesting-places for many insectivorous birds.

Oak timber free from undergrowth. The pastured oak timber differs from the oak groves chiefly in factors which are incident to the increased number of trees. Here we have the ground shaded and an increase in humidity. The ground is less thoroughly sodded, and strictly forest shrubs and herbaceous plants begin to make their appearance, when permitted to do so by the cessation of pasturing. The annual fall of the foliage from the trees contributes a humus to the surface of the soil. The *soil habitat* in this case takes on the characteristic looseness and abundance of decaying plant material which is typical of forest soil. This causes a corresponding change in the animals forming the associations by an increase in the number of mollusks and such other forms as the scavenger beetle. The *undergrowth habitat* is rarely developed to such an extent as to warrant consideration in a general treatise. The *tree-trunk habitat* and the *tree-crown habitat* differ in no essential respect from those of the oak groves. The *forest fungus habitat* becomes here established with considerable regularity. Of these fungi certain forms are commonly seen growing in and through the humus, while others appear only in or upon wood. This treatise need not differentiate between them. Many insects, for example the fungus beetles (Cioidae), as well as members of perhaps a dozen other families of Coleoptera, feed extensively, and in many cases exclusively, upon fungi. In his discussion of this animal community Adams says:* "The general animal population of fungi is so extensive, including mites, sow-bugs, myriapods, and mollusks, in addition

*l. c.

to insects, that no attempt will be made to summarize it here."

The *decaying wood habitat* demands attention in this connection on account of the increase in fallen limbs, twigs, and even standing and fallen dead trees. The decay of wood begins as soon as moisture and fungi succeed in entering the plant tissue. From this point on the animal habitats afforded by the decaying wood pass through a regular ecological series. In a fallen log decay usually begins in the sap-wood layer just beneath the bark. This causes the bark to loosen, providing a home for many insects, such as the adults and larvae of wood-eating beetles (Pyrochroidae, Tenebrionidae, and certain Elateridae) and ants, as well as mollusks and myriapods. Once a foothold is thus gained, the activities of the insects and the fungi which become established act upon the wood beneath until in a few years or many years, depending upon the kind of wood—in oak, many years—the whole is reduced to a mass of thoroughly rotten wood ready to be worked into the humus. There is, of course, a corresponding change in the kinds of animals which are to be found as the process of decay advances. Among those forms encountered in the advanced stages of decaying wood are Coleoptera, larvae of Lucanidae, and certain Scarabaeidae, as well as numerous adult scavenger beetles. Mollusks, particularly the slugs, are common. Such places provide the most favorable hibernation refuges for the female bald-faced hornet.

Oak timber with undergrowth. This formation differs from the preceding chiefly in the fact that the undergrowth gives an added density to the vegetation. Here we find a further increase in shade and humidity. The sub-habitats are quite similar to those of the pastured oak timber save that there is a quite well defined *shrub* or *undergrowth stratum*. This stratum consists, vegetationally, of many annual flowering plants, ferns to some extent, and such woody shrubs as the hazel. The undergrowth provides an abundance and wide variety of food plants, which therefore make for a corresponding variety of animal forms depending upon living tissue for their food, a large number of individuals being, in this case as in the others, insects. For example, the walking-stick, while not limited to this particular sub-habitat, is most frequently met among the twigs of the small

bushes which form the undergrowth in not only the oak but also the other types of forest formation. The density of this formation affords the seclusion preferred by the grey squirrel, while its relative the fox squirrel favors the more scattered forest. There is, however, considerable overlapping of their distribution.

(2) *Oak-hickory*. Oak-hickory formations differ from the oak formations only in the presence of the hickory. The proportion of hickory and oak trees is quite variable, ranging from a few scattered hickory to approximately fifty per cent. Very much the same classification of oak-hickory that refers to the density of the timber will apply, as this combination is found in conditions varying from much scattered groves to solid timber with profuse underbrush. The same analyses for strata or sub-habitats will apply to this as to the oak proper.

(3) *Elm*. Elm is rarely found unmixed with other trees, except in a few groves, the most notable of which are in Sharon township. It has been chosen, however, to represent that timber of which it forms the predominating species. Except for an occasional grove in the upland, where it is not infrequently mixed with oak, it lies uniformly along the flood plains of the rivers and larger creeks, and frequently extends in a thin line along the courses of the smaller streams. It is indicated on all the township maps by X-shaped characters. Along the smaller water courses it is regularly mixed with soft maple, cottonwood, box elder, red hawthorne, river birch, and hackberry. On the banks of the streams is usually a generous mixture of willow.

This so-called elm forest is essentially alluvial, and, as such, presents physical characters which differ uniformly from those found in the oak formations. The ground is regularly level, the drainage rather poor, and the soil black, loose, and rich. Humidity is relatively high, as is the water content of the soil, owing to the poor drainage. As has already been suggested, these formations vary in extent from a thin line of scattered trees along the smaller creeks to forested areas many rods wide along the Iowa River.

Open elm groves. The few upland groves of American elm, the thin lines of timber along the small creeks, and certain elms along the larger water courses fall under this classification. The

latter, those found along the large streams, usually owe their present condition to the removal by man of a large number of trees which were once present. These are without exception closely pastured and so present the same life strata as do the scattered oak groves. The species of animals found in these sub-habitats, however, will differ from those in the oak, inasmuch as the species of plants are different.

Elm timber without underbrush. This formation which should perhaps be called the alluvial plain forest, consists of that mixture of elm with soft maple, etc., as already indicated. Here the trees have usually attained considerable size and present a well developed *tree-crown stratum*, *tree-trunk stratum*, *soil stratum*, *forest fungus stratum*, and *decaying wood stratum*, with, for the most part, an absence of the *undergrowth stratum* due, as in the case of the oak, to pasturing. These various life strata will yield to a similar treatment to that found in the oak formations. It is worthy of note, however, that the increased humidity will cause an increased number of fungi, and consequently an increase in the number of fungus-feeding forms. Certain mammals are found here which cannot be assigned to a particular stratum save that they nest in the tree trunks; the most notable of these are the raccoon and the fox squirrel. I have observed signs of raccoons in such formations at numerous places along the Iowa River and along the larger tributaries of that stream, for example, Clear Creek west of Tiffin.

Elm forest with undergrowth. There are a few areas which are still covered by unpastured alluvial forest; one of these is found in Fremont township, Section 12. This formation differs from the preceding only in the presence of an abundant tangle of undergrowth and consequently has all strata of life present. These areas, while few in number, offer what are at present the most nearly original conditions of any animal habitat in the county and present a paradise to the collector of invertebrate forms.

(4) *Willow.* The willow formations of the county can hardly be dignified by the name forest. They have been given chiefly because they occur as definite formations at intervals along the banks of the larger streams and are regularly found in a thin

line along most of the small creeks. They are indicated on the township maps in stippling. The willows have been elevated in this treatise to a place of a separate heading chiefly because they form the only natural trees for the nesting of birds along streams which wander through the broad cultivated areas that once were prairie. Along these smaller streams they frequently occur in pure formations; along the larger water courses they usually occur mixed with birch and a scattering of other trees. Their trunks and foliage provide for a number of insects, the most of which are specific feeders upon willow. As these growths are usually so limited in extent, they provide insufficient shade for undergrowth and are commonly too scattered to have any effect upon the soil. Therefore their life strata may be said to be limited to two, the *tree-crown stratum* and the *tree-trunk stratum*. In many instances, there are thickets of willow which are only shrub-like in size; in these cases there will of course be no *tree-crown stratum*, and the whole formation can be roughly divided into what would correspond to an *undergrowth stratum* and a *soil stratum*.

(5) *Hazel*. Hazel has already been mentioned as forming a part of the undergrowth in the oak forest. However, in many cases it occurs unprotected by trees. It is one of the plants quick to establish itself after the removal of the oak. In fact, the greater number of hazel formations throughout the county will be found on ground that was once occupied by oak or oak-hickory. The hazel seldom attains a height of more than six feet, and as it is usually pastured it occurs in clumps between which is a firm blue-grass sod. It is found regularly on high, well-drained land where the humidity is low as compared, for example, with the elm formations. It provides, by its annual crop of nuts, food for the white-footed mouse and the chipmunk. The latter, however, is not a regular resident of hazel thickets except in the more rocky places where the crevices provide it with easily prepared shelter. The hazel has, of course, its own set of insect feeders, and the hazel brush is regularly inhabited by such birds as the thrush. These formations permit of subdivision into not more than two life strata or sub-habitats. These are the *soil stratum* and that stratum composed of the brush itself, which, as

in the case of the willow thicket, will bear a rough comparison with the *undergrowth stratum* of the timber lands. An additional stratum of decaying wood must also be taken into consideration if the hazel is occupying land that still bears evidence of former forest in the shape of stumps and other remains of once living trees. Hazel formations are represented on the township maps by interrupted heavy lines.

(6) *Thickets*. Under the heading of thickets are taken into consideration such miscellaneous formations of young tree growth as have not yet reached sufficient size to be dignified by the name of forest. These usually contain a mixture of many species of woody plants, not infrequently hazel, young oak, young hickory, ash, etc., being present. They usually occur in small patches on the uplands, which are ordinarily occupied by oak. For the most part they represent an attempt of nature to reforest areas that have been denuded of their trees. This process has not yet reached that stage for the establishment of any one form as the predominating species. The abundance and variety of these plants make such thickets the home of many of our birds, including the vireos, thrushes, etc. This is also accomplished by the great abundance of insect life which is present. Here, too, we find the blue racer, attracted no doubt by the large number of bird nests with their eggs and fledglings, as well as the abundant insect life. With reference to life strata, these thickets yield to such analysis as that applied to the hazel. They are represented on the township maps by irregular tangles of wavy lines.

(7) *Cleared land with stumps still present*. This is perhaps the most artificial of all the habitat classifications, inasmuch as it does not discriminate between the species of trees of which the stumps are the remains. It is taken into consideration because it provides an animal habitat differing from both the forest and the land after it has been put under cultivation. Its chief physical features different from the forest are a lack of shade and living trees and a decrease in humidity. Of the forest animals, it retains only those which feed upon decaying wood or fungi. It therefore must be said to represent the *soil stratum*, the *decaying wood stratum*, and the *forest fungus stratum* of the

forest from which it has been derived, minus shade and with a decreased humidity and humus, if such statement can be accepted. Such areas are represented on the township maps by v-shaped marks.

PRAIRIE-FOREST MARGINAL ZONE

The zone lying at the juncture of the prairie and the forest has already been discussed and needs but little elaboration here. It is a narrow strip of intermingling prairie and forest plants which is consequently populated by individuals of the animal life from each of the meeting habitats but is never composed purely of forms from either.

AQUATIC HABITATS

The aquatic habitats of Johnson County are naturally of much more limited extent than the terrestrial ones. They permit of logical and natural division into two groups, those of *running water* and those of *standing water*. Each will be found in turn to be composed of various stages in an ecological series.

RUNNING WATER SERIES OF HABITATS

It is generally recognized that in the reduction of any land elevation to its base level the establishment of the streams follows a perfectly definite and regular series of steps. First, the actual run-off after rainfall succeeds in producing a ravine, which, attaining a sufficient depth, acquires ground water and becomes a brook. The brook increases its length and broadens its valley by further cutting until it becomes a creek, and the creek by like processes grows into a mature river. Each of these stages presents a separate and definite series of animal habitats which go hand-in-hand with a regular, well defined, ecological succession of animal associations.

(1) *Brook habitats*. The brook represents the first stage in the establishment of a permanent stream—the ravine has just captured ground water. The main physical features of the brook are its V-shaped valley without a flood plain and its alternate rapids and pools. It has a low oxygen content, due to the fact that the water has been but a short time exposed to the air, contains but little vegetable debris or organic matter, due to the

fact that but few plants have become established in its waters. The water is shallow and therefore well lighted to the bottom. Each brook has within itself a set of conditions which make possible the occurrence of several associations of animals, as I have previously pointed out.* There is an association of animals in the rapids which are capable of resisting the current, either by attachment or seeking shelter, or by strong positive rheotactic reactions. Within the pools, conditions permit the existence of a *surface film association* of animals, a *free-swimming association*, and a *bottom association*. These brooks have not been indicated upon the maps; they occur, however, at the head waters of every branch of the larger streams and are also found feeding into the rivers between these streams. A detailed description of the forms inhabiting one such brook in Johnson County is given in the article just cited. It is sufficient to note here that they are mostly insect forms and aquatic snails.

(2) *The creek habitats.* The creek is characterized by its U-shaped valley, having acquired a narrow flood plain. The proportional extent of pools and rapids has been altered into more extensive pools separated by occasional rapids. There is, of course, an increase in the volume of water which causes a greater depth to the pools and does not allow sunlight to reach the bottom in all places. There has been a gradual increase in the amount of organic matter and coincident with this an increase in the number of algae in the water. This permits a greater profusion of other micro-organisms, which in turn provide food for a larger number of individuals and a greater variety of species of the invertebrates. The great number of such invertebrate forms as the crustaceans and insects, together with the increased depth of the water, provide for the existence of such small fishes as darters, dace, shiners, and chubs. I have also taken the common "blue-spotted" or "green" sunfish from Saunders and Turkey Creeks. As it feeds almost exclusively on other fishes, insects, and crayfish, its presence is an index to the abundance of such life in the creek. The pools permit of such analysis as the pools of the brooks. Rapids are frequently of sufficient variety to need classification, as is also

*Macroscopic fauna of a small brook,' *Iowa Academy of Science, Proceedings*; 22 (1915), pp. 363-374.

sometimes the case with those of the brooks. This classification most usually takes the form of *grassy rapids*, *stony rapids*, etc., each with its differing associations of animals. Those streams of the county sufficiently constant throughout the year to merit being called creeks are labelled upon the maps. They are as follows: Knapp, McAllister, Lingle's, Mill, Jordan, Silver's, Mud, Turkey, Saunders', Rapid, Ralston, Snyder's, Buck, Otter, Pardieu, Clear, Old Man's, of which Picayune and Dirty Face are tributaries, and Deer. These have all been located and their extent given in the chapter on drainage.

With the increased size of the creek and the increased depth of its valley, the processes of erosion have gone along far enough to have done considerable sorting of the soil materials. This is evidenced by deposits of sand and gravel at the rapids and on the opposite bank of the stream from that which is now being cut. The finer constituents of the soil go, for the most part, to make up loam and silt, which is carried considerable distances, and frequently a small mud bank will take the place of the sand bar at the inner side of the curve of the stream. Of almost all of these creeks the course is being altered from year to year except where they flow directly over well-defined rocky channels as in the case of Turkey Creek throughout part of its extent. There is, of course, every degree of intergradation between the brook and the creek and again between the creek and the river. Some of the Johnson County creeks, more notably Clear Creek and Old Man's Creek, present certain of the characters of the larger and more mature stream; these characters are particularly a broad flat valley and a placid course rarely interrupted by rapids. Such fishes as the common bullhead, for example, are taken quite regularly as far up Clear Creek as Tiffin. Debris along the banks of the creeks forms a favorite haunt of the common water snake.

(3) *River habitats.* The course of the rivers of Johnson County, the Iowa River and the Cedar River, has been discussed in sufficient detail. The mature river represents the final stage in the development of a stream before the land has again reached base level. It is practically one long continuous pool, interrupted at rare intervals by rapids. The forms of life which

it can support are many except, of course, such animals as would require turbulent water for oxygenation. In these mature streams there is an abundance of organic matter, a corresponding wealth of micro-organisms, and with this a great variety of small crustaceans and insect forms. These in turn feed other larger forms which in their numbers provide abundant food for a large variety of vertebrates, chief among which are the fishes. In such a stream as the Iowa River these fishes often attain considerable size, carp and catfish taken in the vicinity of Iowa City being reported to have weighed more than thirty pounds. Necturus, the lampreys, and the gars are forms that are frequently met with in addition to the regular edible fishes.

Within the river itself there are many sub-habitats, each with its own peculiar association of animal life. The quantity of water provides for an extensive *free-swimming animal association*. There is a *bottom association* which varies with the variations in character of the bottom from those forms adapted to live in soft oozy mud to those capable of supporting themselves on gravely rocky bottom. To these must be added a *shallow-water association*, or those forms usually distributed in the narrow strip of shallow water at the very edge of the stream. Then there is the *surface-film association*, containing such forms as are adapted to existence on the surface film, such as the water-strider. The *river bank habitat* is practically identical with the creek bank habitat, and for that reason is discussed here only. It consists of such forms as require burrows for their homes but depend upon the water for locomotion and food. The most notable of these are the muskrat and its enemy the mink.

(4) *Marginal habitats*. A subdivision of marginal habitats is made regardless of the preceding treatment of the river and creek banks. It has already been hinted at in connection with the sorting of materials by the creek. As stated in the general discussion at the beginning of the chapter, it is, strictly speaking, terrestrial, but has been classified with the aquatic formations because it is the immediate result of the recent action of the stream. It consists of *mud flats* and *sand bars*. No attempt was made to locate these upon the maps on account of the inconsistency of their positions in the upper and lower parts of the

river valley within the county. As the river passes through its rocky bluffs, these will remain more constant and can be located in general as lying on the short side of any loop of the stream; in other words, these materials are thrown down as the river dashes its force against the opposite bank. Both the sand bar and the mud flat, of course, lose their moist character as the season advances. Each has its distinct group of animals. Examples for the *sand-bar* would be the ant lion larva, and the tiger beetle, and for the *mud flat* would be the Elapharus beetle. The sand bars also provide a place for the snapping turtle and soft-shelled turtle to deposit their eggs.

THE STANDING WATER SERIES

Bodies of standing water undergo a succession of changes comparable to those in the establishment of streams as the process of attaining base level is carried out. In the case of standing water, however, this is a retrogressive action, as lakes, which represent the original condition, are, by cutting off of their outlets and filling in of their basins, reduced to mere ponds, and these in turn to swamps and bogs, and eventually to dry land. As was indicated in the paragraph on lake basins, lakes are only nominally present in Johnson County at this time. The plant and animal life of any lake can be clearly understood only by an understanding as to the cause of the lake. For example, a lake of purely glacial origin such as Swan Lake would not be expected to have identical flora and fauna with an ox-bow lake formed by the river and fed by occasional overflows from the stream which gave it existence. Swan Lake, the most extensive lake in the county, has been so reduced within the last fifty years that it is little more than a shallow swampy pond. The pasturing of its banks and the watering of stock from it have done much to alter its original associations. It still provides a nesting place for the coot and the gallinule, and forms a resting place for many of our migratory water birds during their spring and autumn travels. It has become so shallow and so completely clogged with vegetation that muskrats build their homes in the deepest parts.

(1) *Ponds*. As with the lakes of the county, the ponds may

have either one of two natural origins, glacial or ox-bow. An additional origin permits the existence of artificial ponds made by man. While these are not original conditions, the majority of them have been established long enough to have acquired most of the animal forms of standing water. The ponds of ox-bow origin represent simple detached pools of the river and except for the fact that the lack of motion of the water reduces the oxygen content, the conditions are extremely similar. This is rendered more universally true by the fact that almost annually the river overflows its banks sufficiently to claim these ponds and to restock them with animal life. Several fishes, chiefly carp, buffalo, and bullheads, being naturally adapted to life in the more sluggish parts of the stream, are able to maintain themselves in these ponds throughout the year. However, as the ox-bow becomes reduced by the decomposition of material and the establishment of rooted plants, the decreased depth of its water will prohibit the maintenance of the larger animals. The ponds of the county are represented on the map (Plate III) by circles, each with a dot in the center. Many of these will be intermittent, especially in a dry season such as that of 1896. Even the more intermittent of the ponds provide a breeding place for toads, frogs, and salamanders, and here their larvae develop. Here, too, are normally found numbers of aquatic and semi-aquatic gasteropods.

(2) *Swamps*. Swamps and bogs represent the half-way mark between a body of standing water and dry land. Here the vegetation is rich but hydrophytic, and shades into the mesophytic at the margins. Such plants as flags, rushes, and cat-tails are common. The soil of the swamp is normally super-saturated with moisture throughout the year. Thus a number of its forms of life are aquatic or semi-aquatic. Swamps and bogs have been indicated upon the county map by stars. They are frequently found, where extensive, surrounding a body of standing water. In such cases their vegetation provides material for the muskrat to build his home. The swampy lands in the county form resting places for Wilson's snipe and the robin snipe on their way to and from the south. Here red-wing black-birds nest, and bitterns come daily to take their toll of the tiny

swamp frogs and leopard frogs that abound in such places feeding on the myriads of winged insects that hover over the water and among the plants.




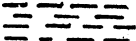





On the map, no attempt has been made to discriminate between the merely boggy land and the swamp. Many of the smaller bodies, especially in Graham and Scott townships, will not remain damp through the summer months, but their vegetation does remain different from that of the land about them in spite of excessive pasturage, affording a different association of insect life. Of the more extensive swamps of the county, all are fairly constant throughout the year.

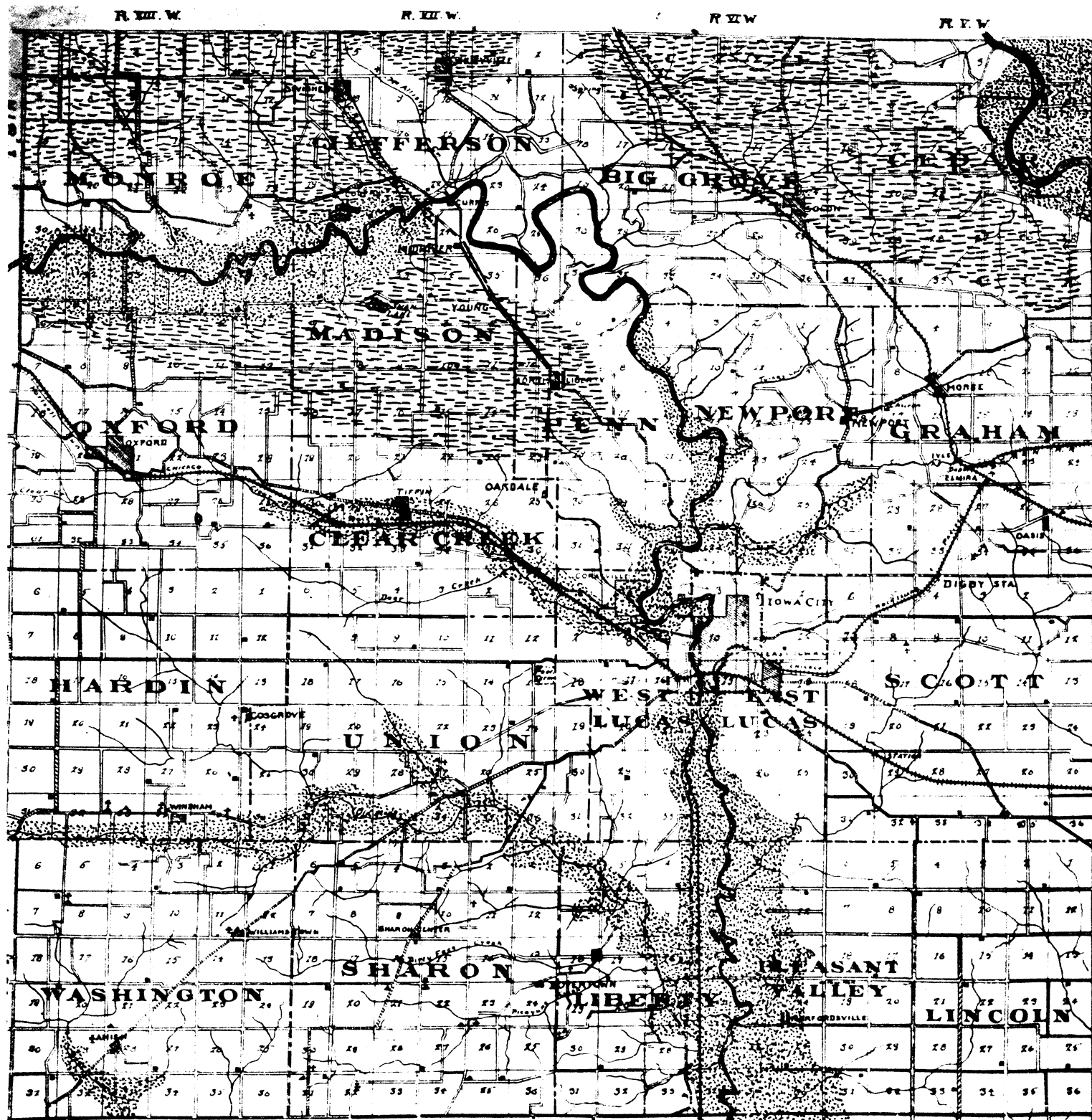
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KEY TO PLATES IV-XXXIII

Oak.....	
Hickory	
Elm.....	
Hazel.....	
Thicket.....	
Willow	
Cleared land, with stumps.....	
Solid timber, without underbrush.....	
Solid timber, with abundant undergrowth.....	



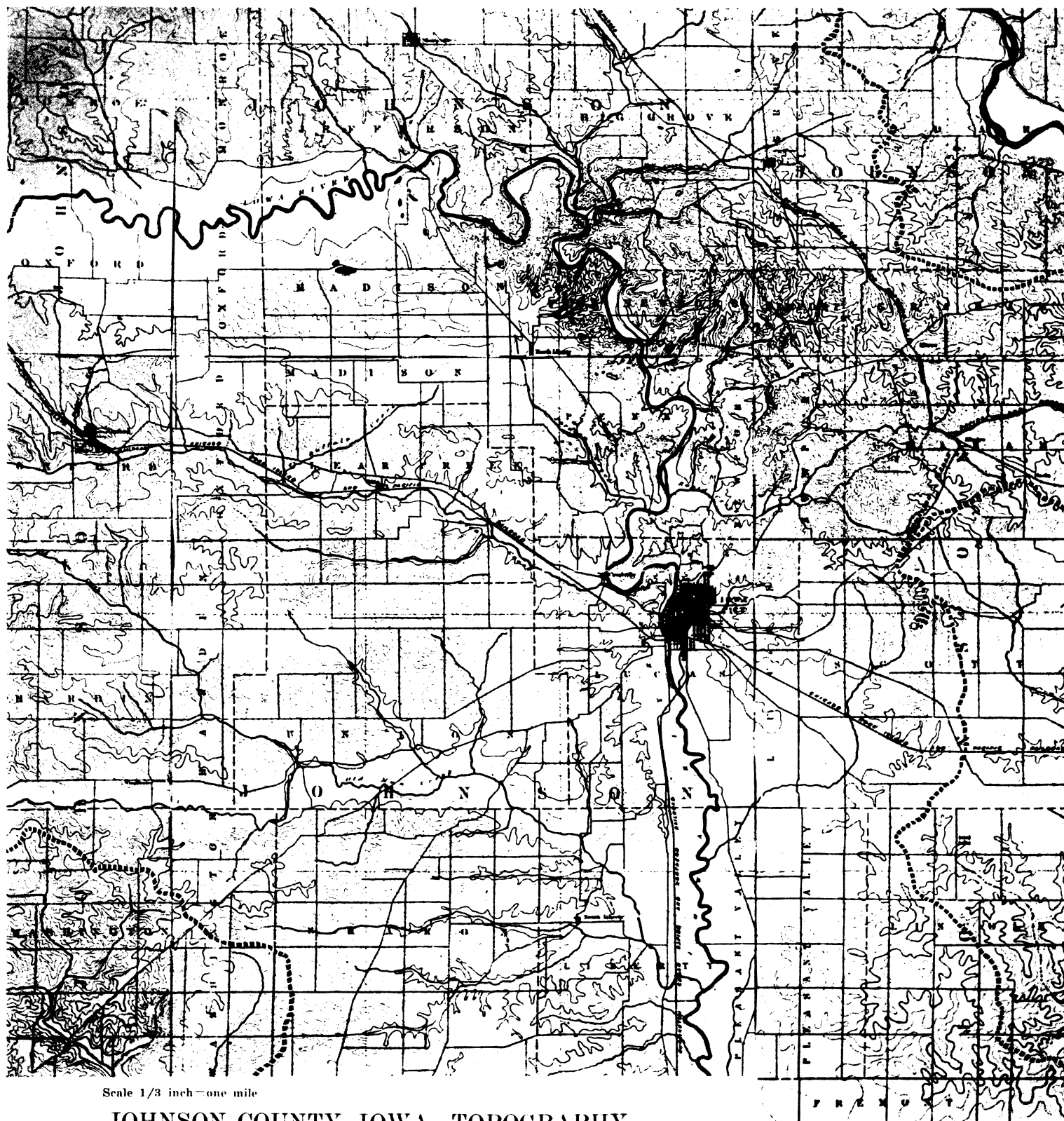
Scale 1/3 inch = one mile

- School
- Church
- Cemetery
- Drift
- Alluvium
- Loess



JOHNSON COUNTY, IOWA



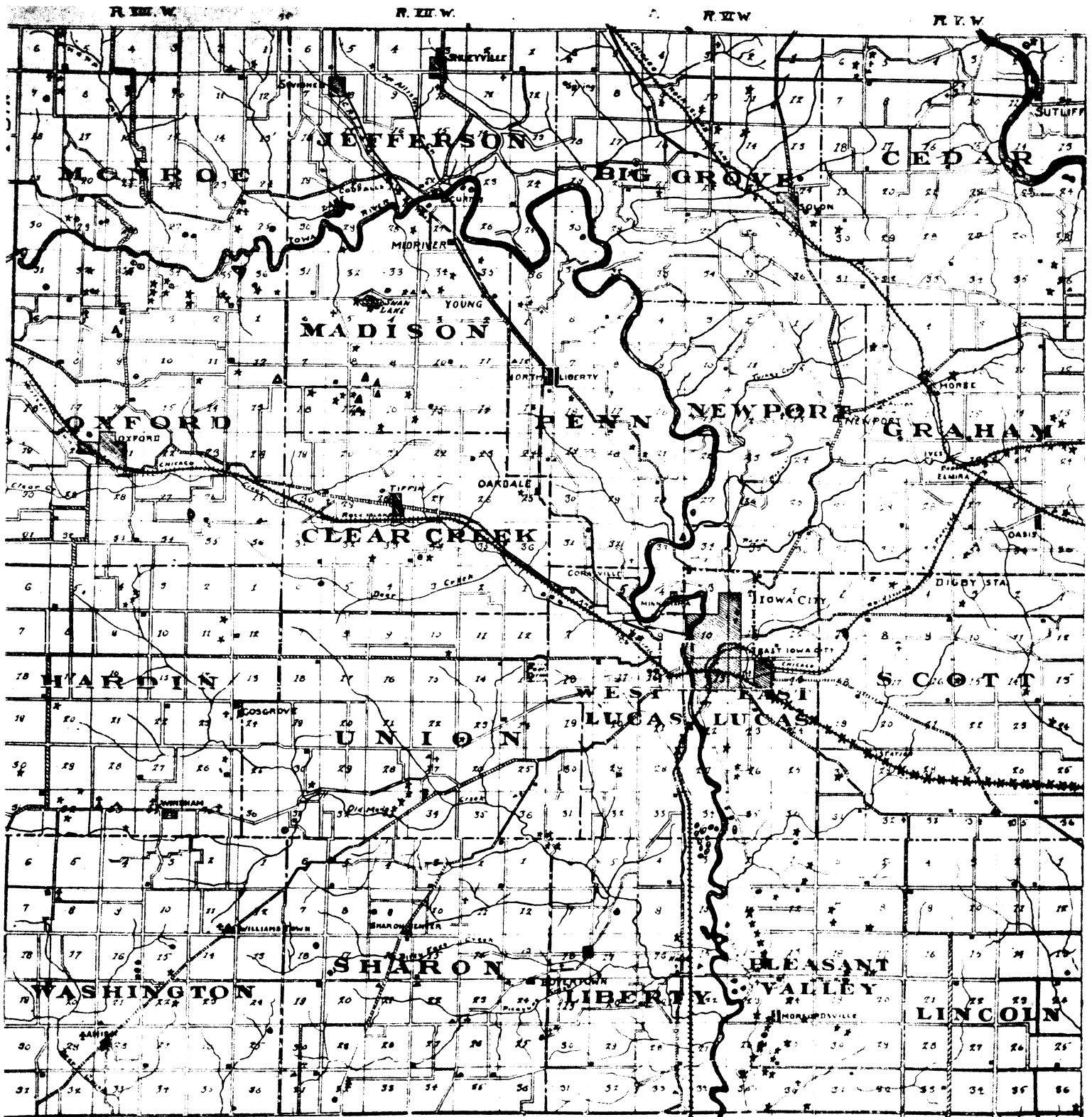


Scale 1/3 inch—one mile

JOHNSON COUNTY, IOWA—TOPOGRAPHY

Broken lines indicate watersheds



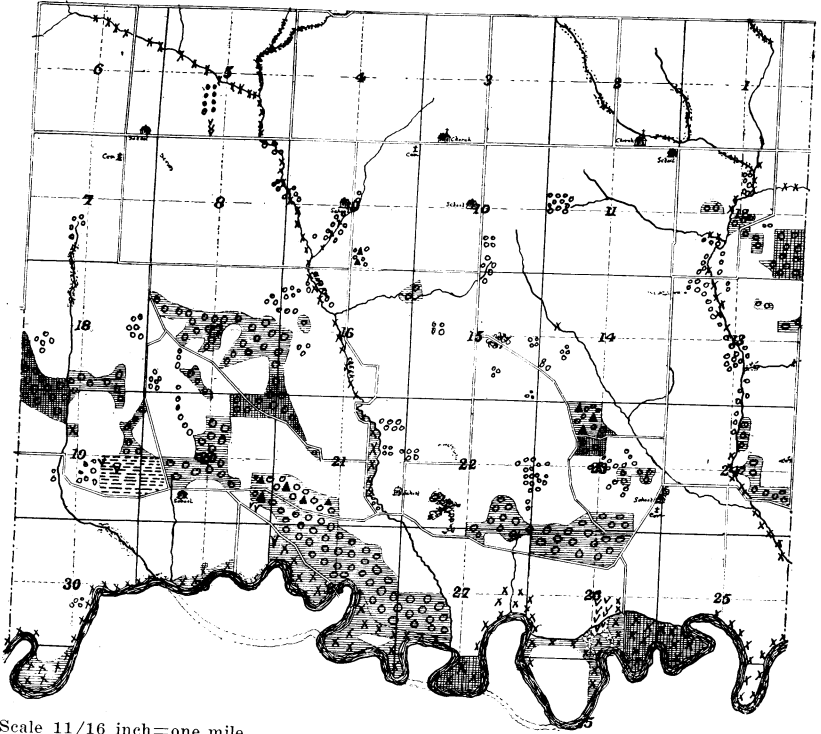


Scale 1/3 inch = one mile

- | | |
|-----------|---|
| School | ■ |
| Church | ▲ |
| Cemetery | ✝ |
| Prairie | × |
| Sand-dune | △ |
| Pond | ○ |
| Swamp | ★ |

JOHNSON COUNTY, IOWA

PLATE IV



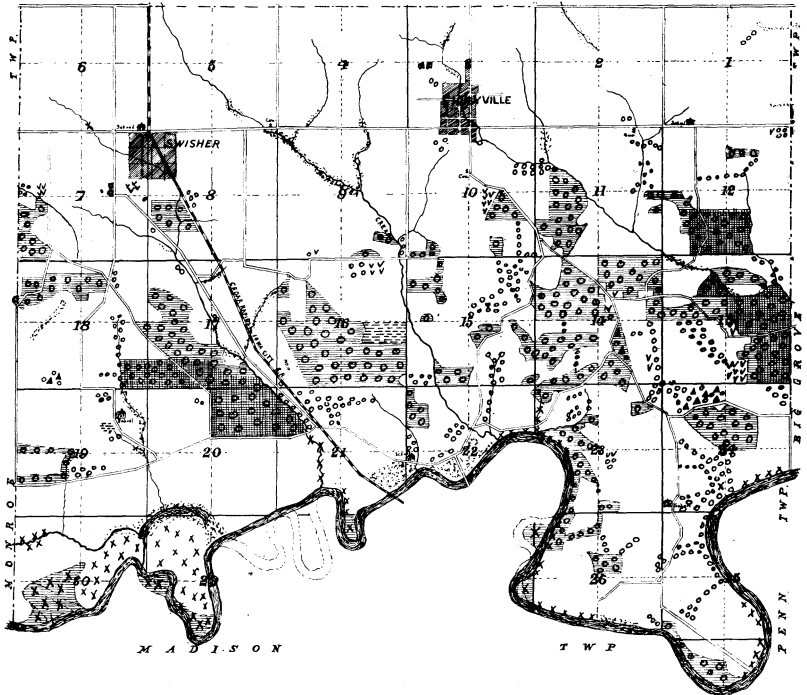
Scale 11/16 inch=one mile

MONROE

Township 81 North Range 8 West



PLATE V



Scale 11/16 inch=one mile

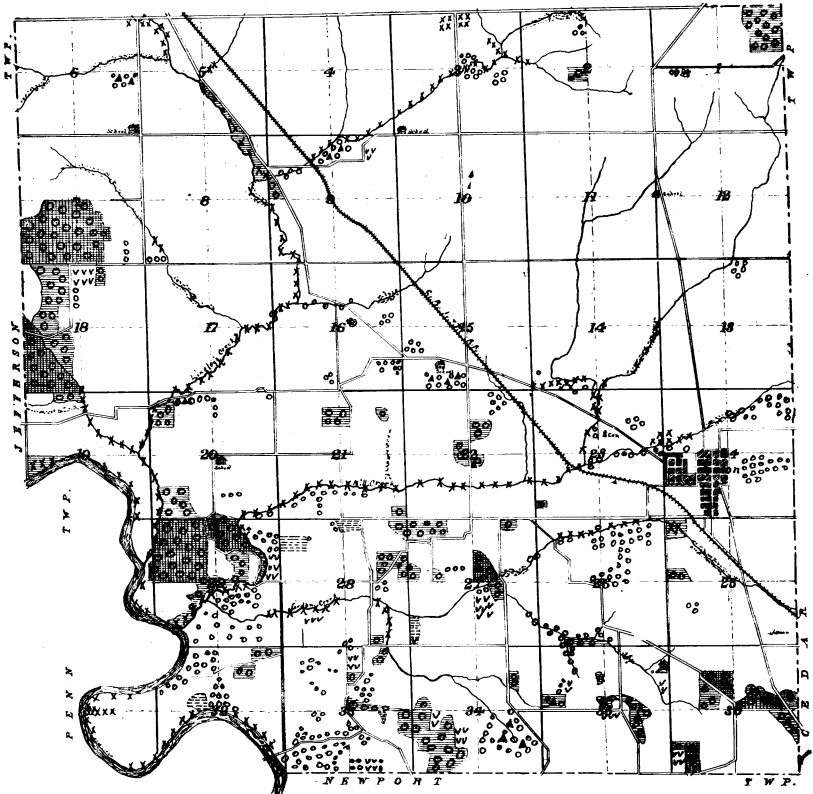
JEFFERSON

Township 81 North Range 7 West





PLATE VI



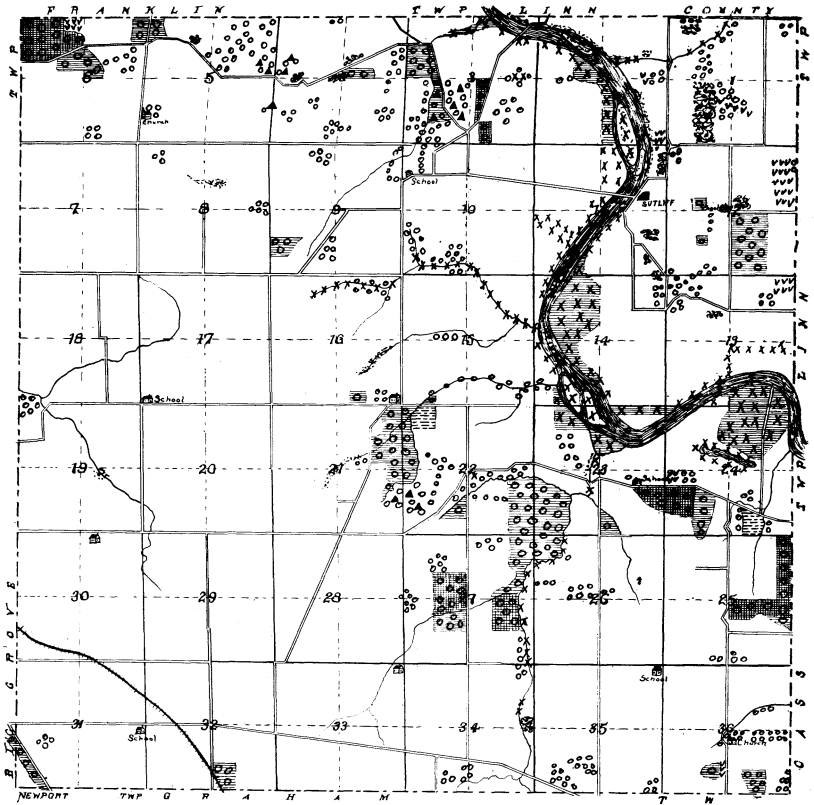
Scale 11/16 inch=one mile

BIG GROVE

Township 81 North Range 6 West



PLATE VII

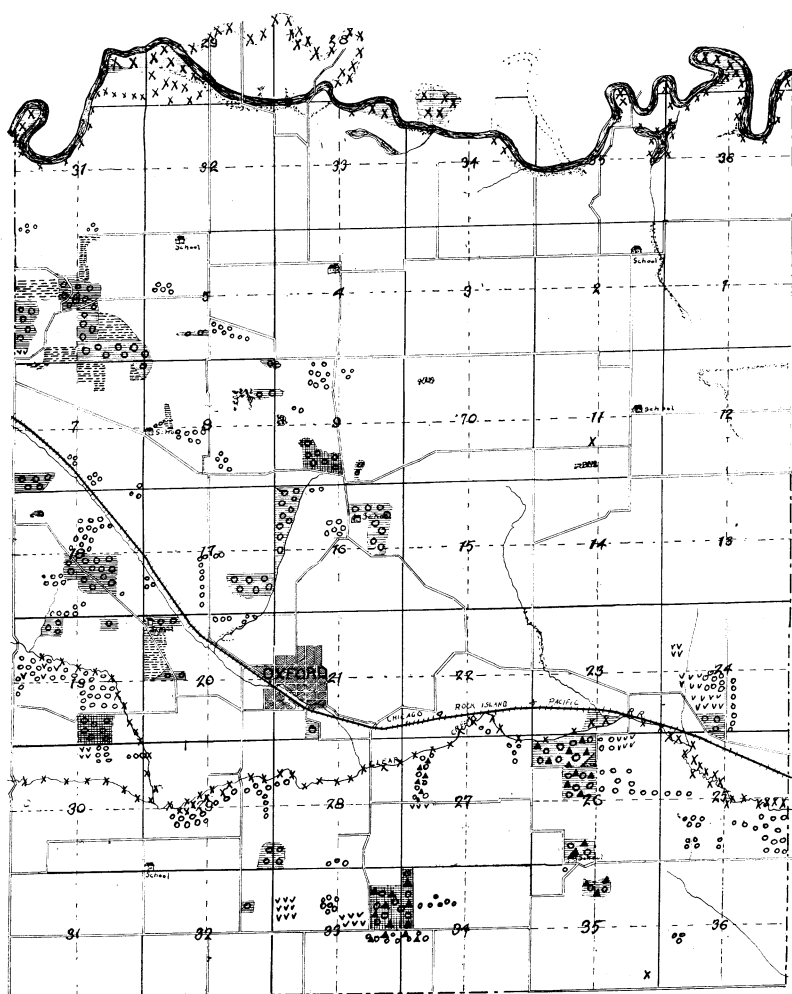


Scale 11/16 inch=one mile

CEDAR

Township 81 North Range 5 West





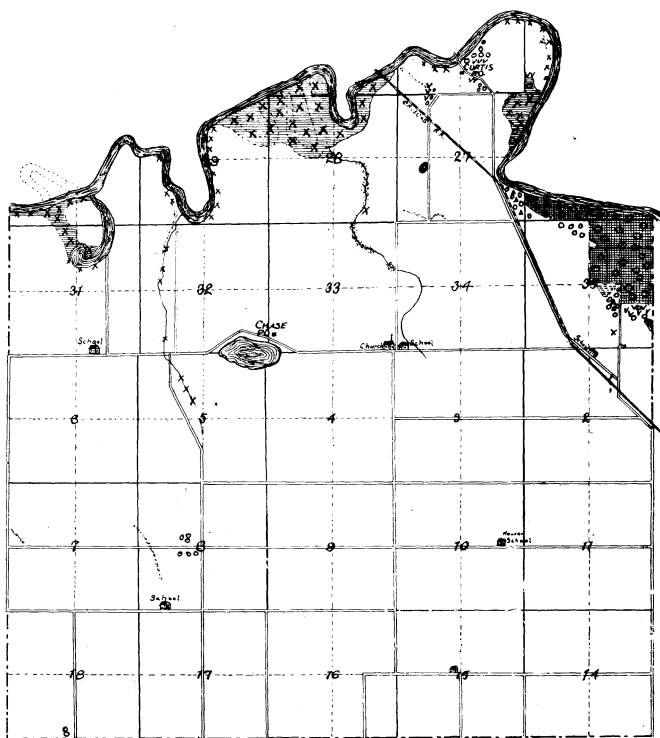
Scale 1 1/16 inch=one mile

OXFORD

Township 80 and 81 North Range 8 West



PLATE IX



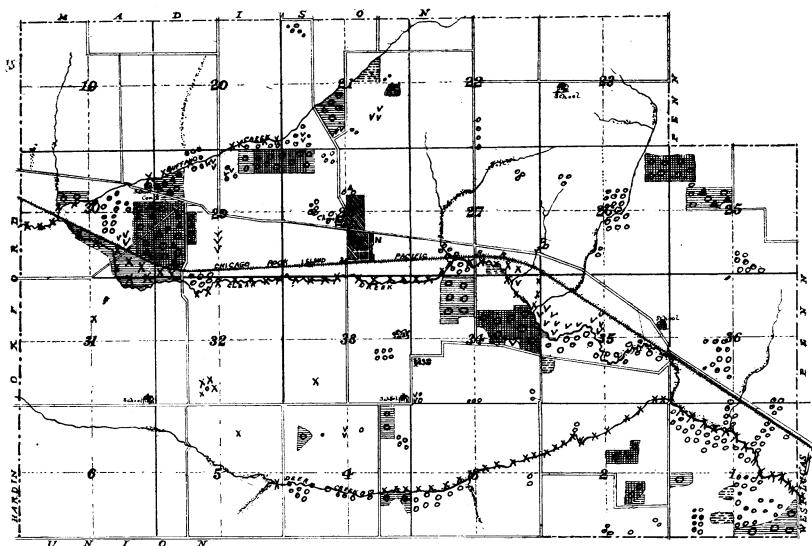
Scale 11/16 inch=one mile

MADISON

Township 80 and 81 North Range 7 West



PLATE X

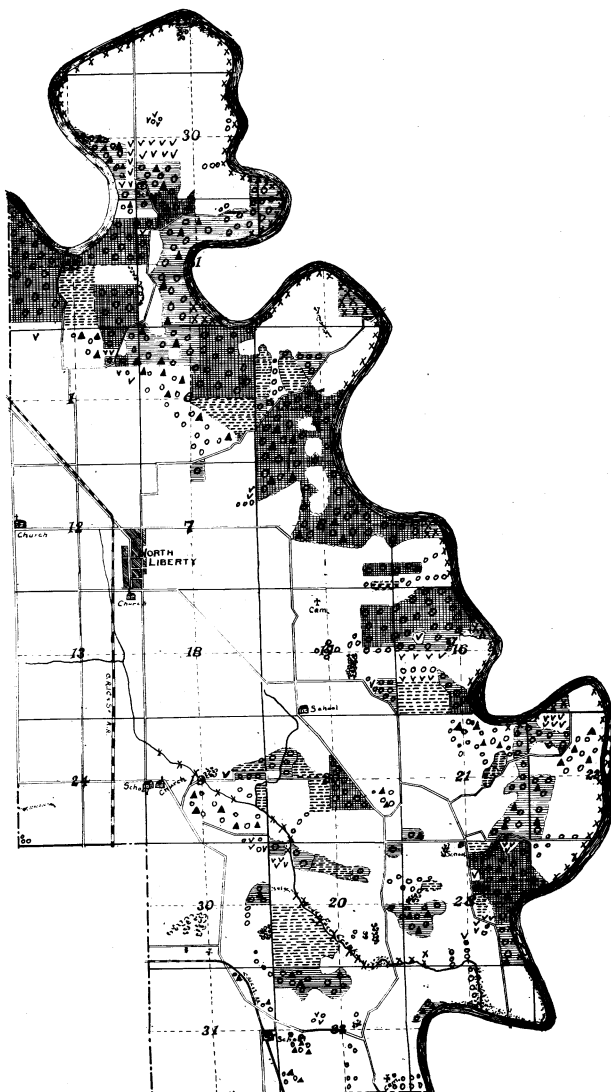


Scale 11/16 inch=one mile

CLEAR CREEK

Township 79 and 80 North Range 7 West





Scale 11/16 inch=one mile

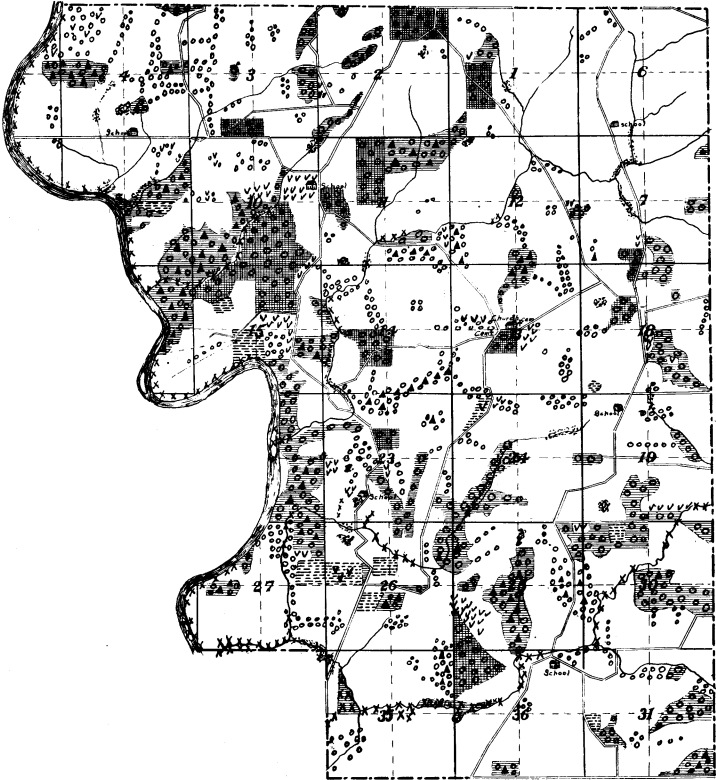
PENN

Township 80 and 81 North Range 6 and 7 West





PLATE XII



Scale $\frac{11}{16}$ inch=one mile

NEWPORT

Township 80 North Range 5 and 6 West



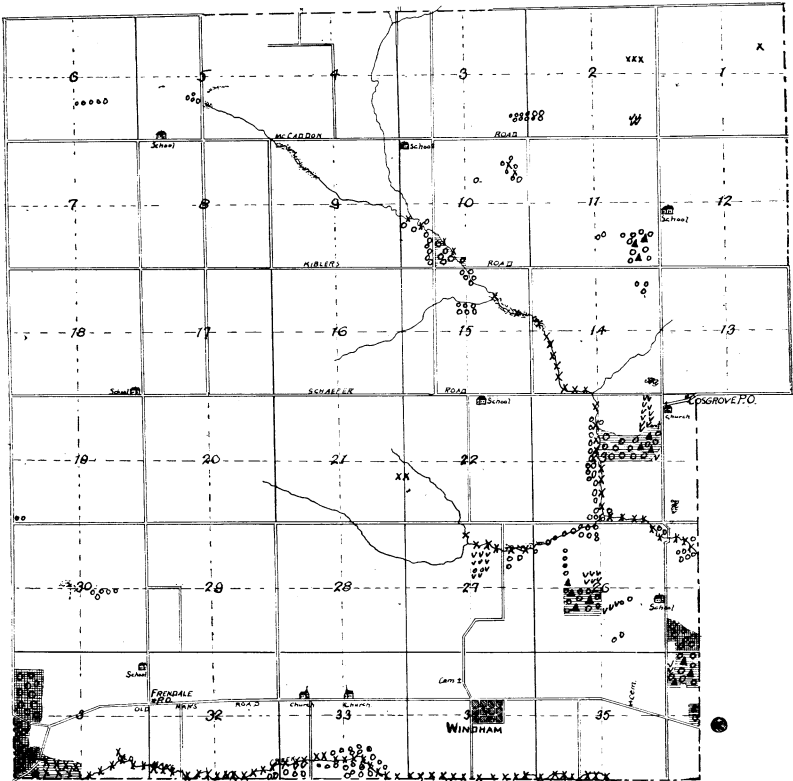
The map is a detailed topographical or tactical map of the Elmira, New York area. It features a grid system with letters (X, Y, Z) and numbers (1-10). The map includes features like 'STATIONERS ROAD', 'ELMIRA', 'DESPOND', and 'CHURCH'. It also shows various symbols like dots, circles, and shaded areas, likely representing different types of terrain or structures. The map is oriented with North at the top.

GRAHAM

Township 80 North Range 5 West



PLATE XIV



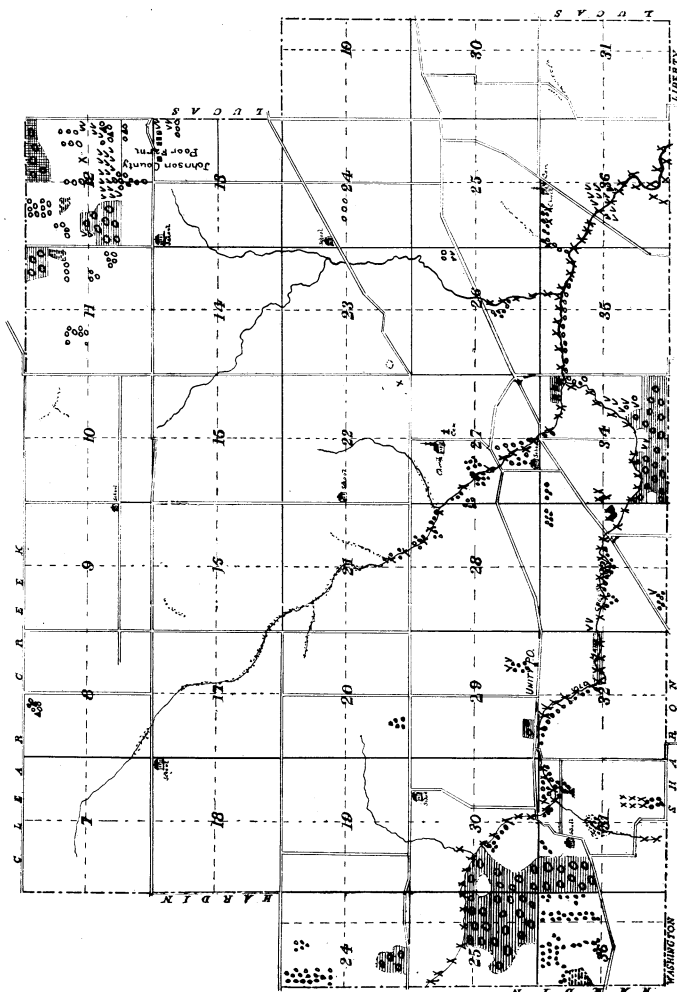
Scale 11/16 inch=one mile

HARDIN

Township 79 North Range 8 West



PLATE XV

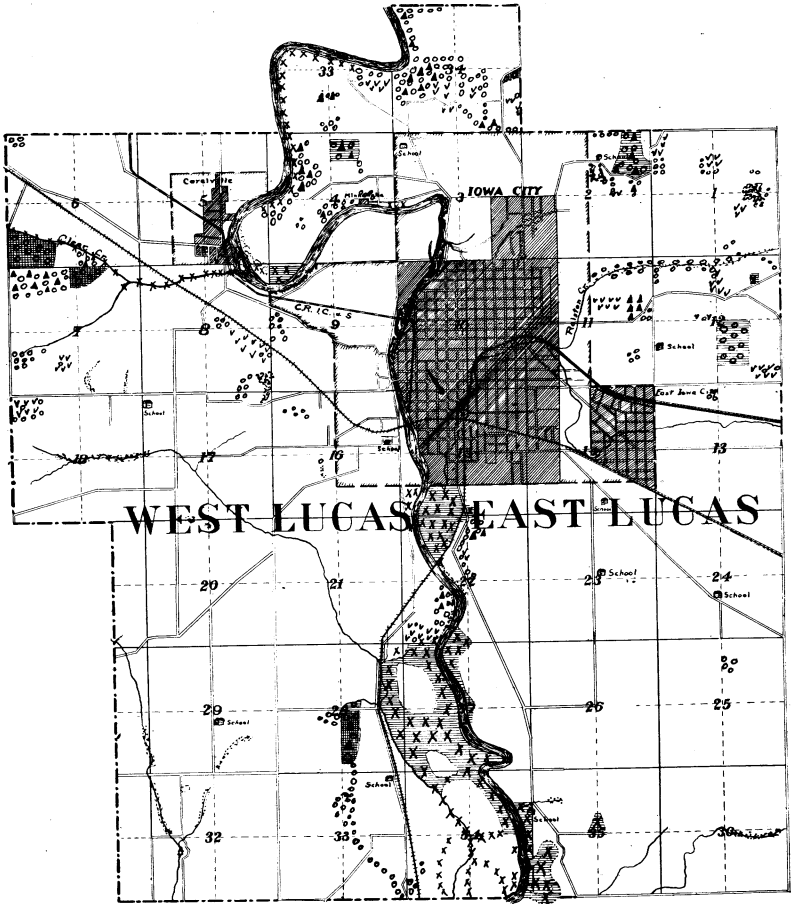


UNION

Township 79 North Range 6, 7, and 8 West

Scale 11/16 inch = one mile



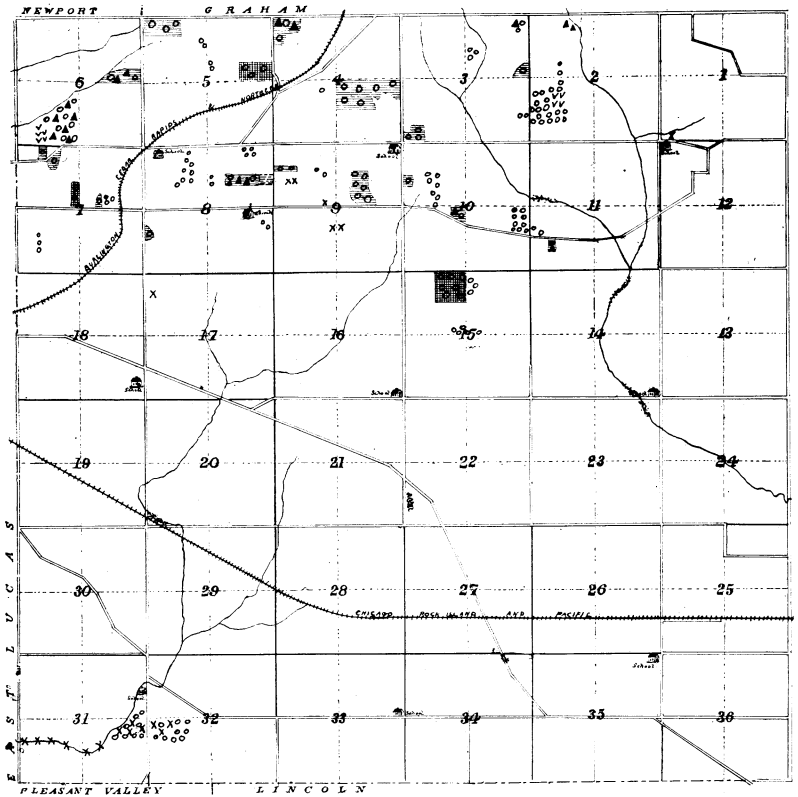


Scale 11/16 inch=one mile

EAST AND WEST LUCAS
Township 79 and 80 North Range 6 West



PLATE XVII



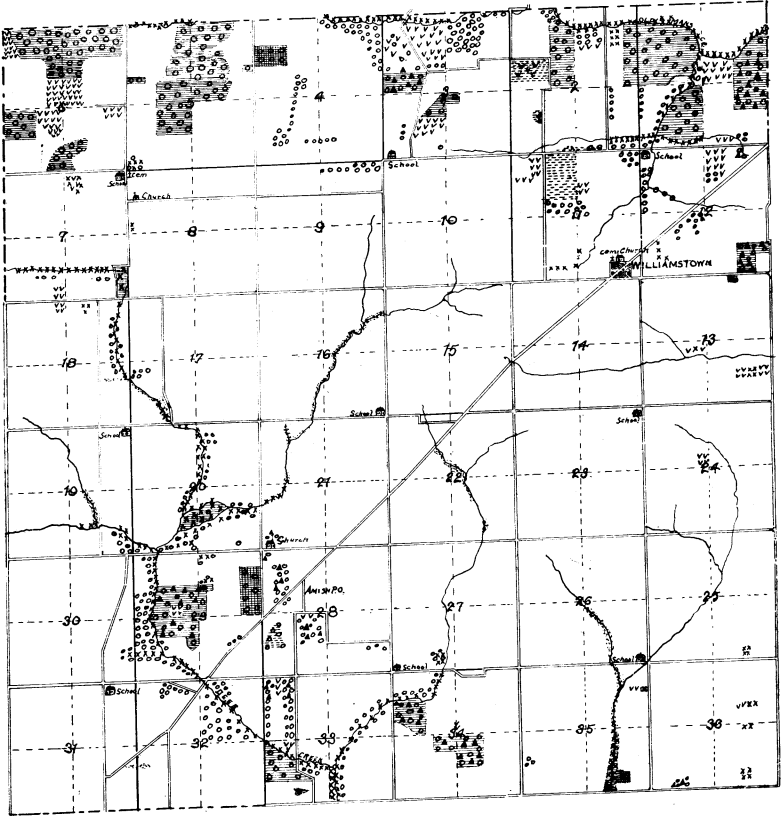
Scale 11/16 inch=one mile

SCOTT

Township 79 North Range 5 West



PLATE XVIII



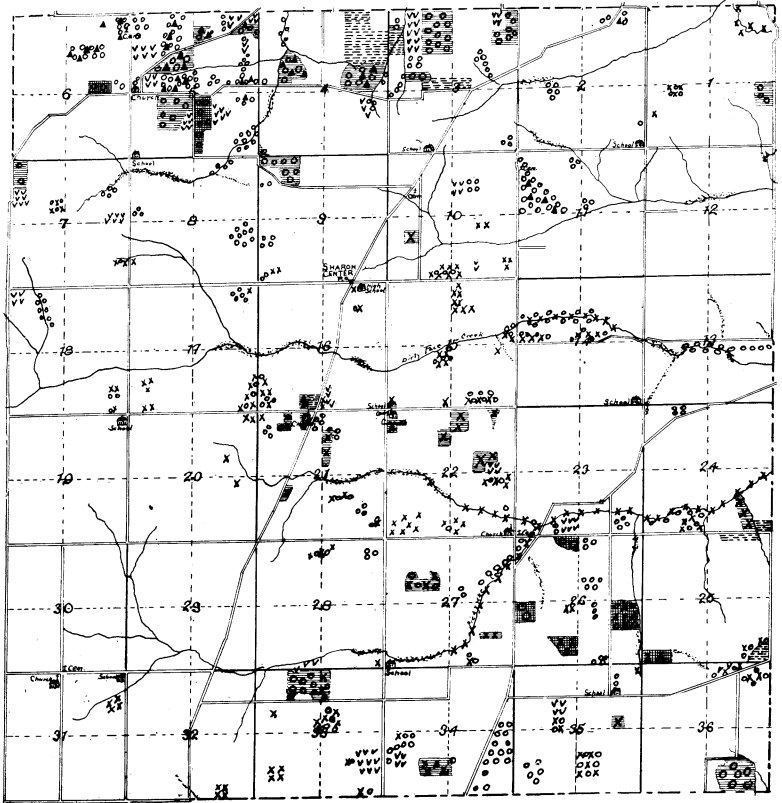
Scale 11/16 inch=one mile

WASHINGTON

Township 78 North Range 8 West



PLATE XIX



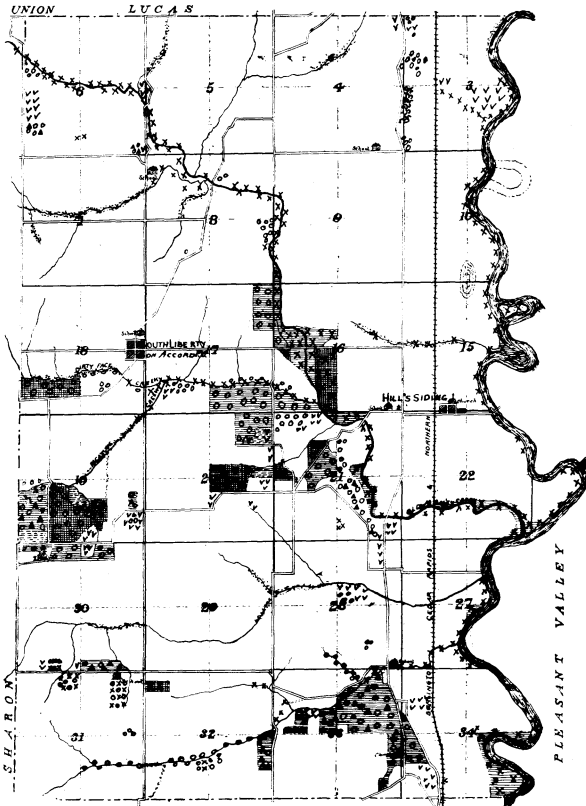
Scale 11/16 inch=one mile

SHARON

Township 78 North Range 7 West



PLATE XX



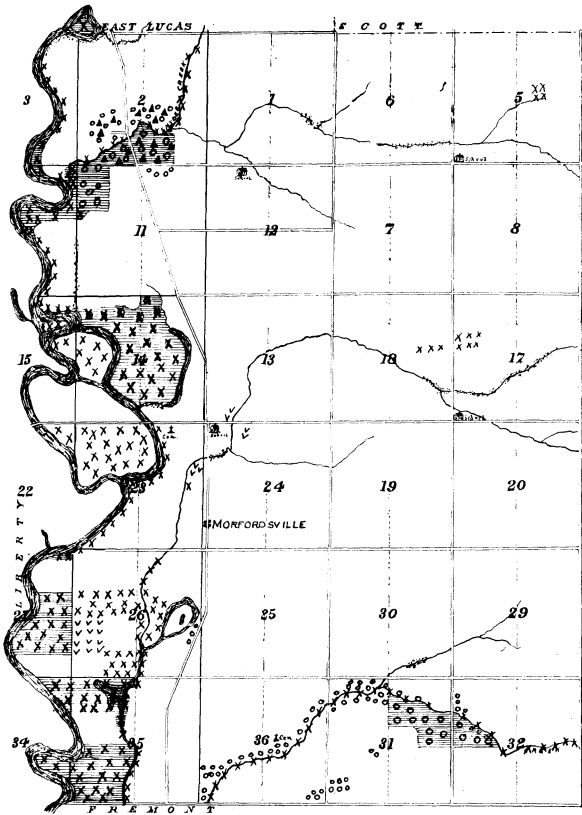
Scale 11/16 inch=one mile

LIBERTY

Township 78 North Range 6 West



PLATE XXI



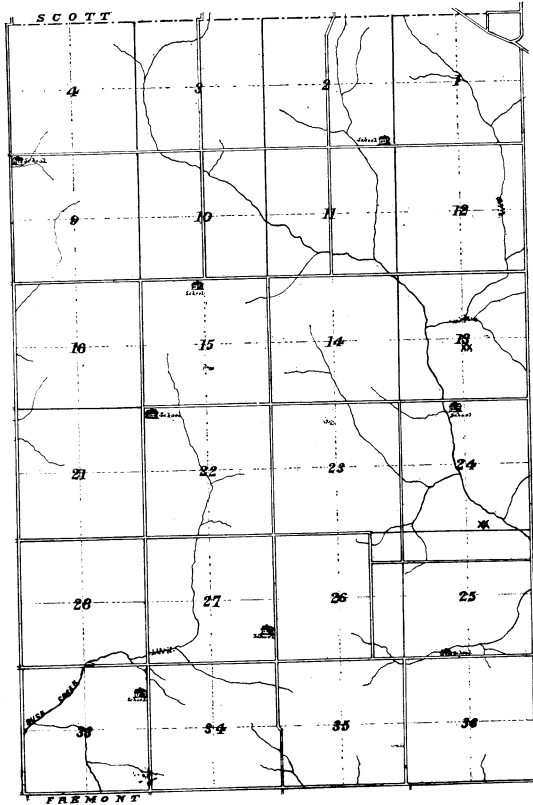
Scale 11/16 inch=one mile

PLEASANT VALLEY

Township 78 North Range 5 and 6 West



PLATE XXII

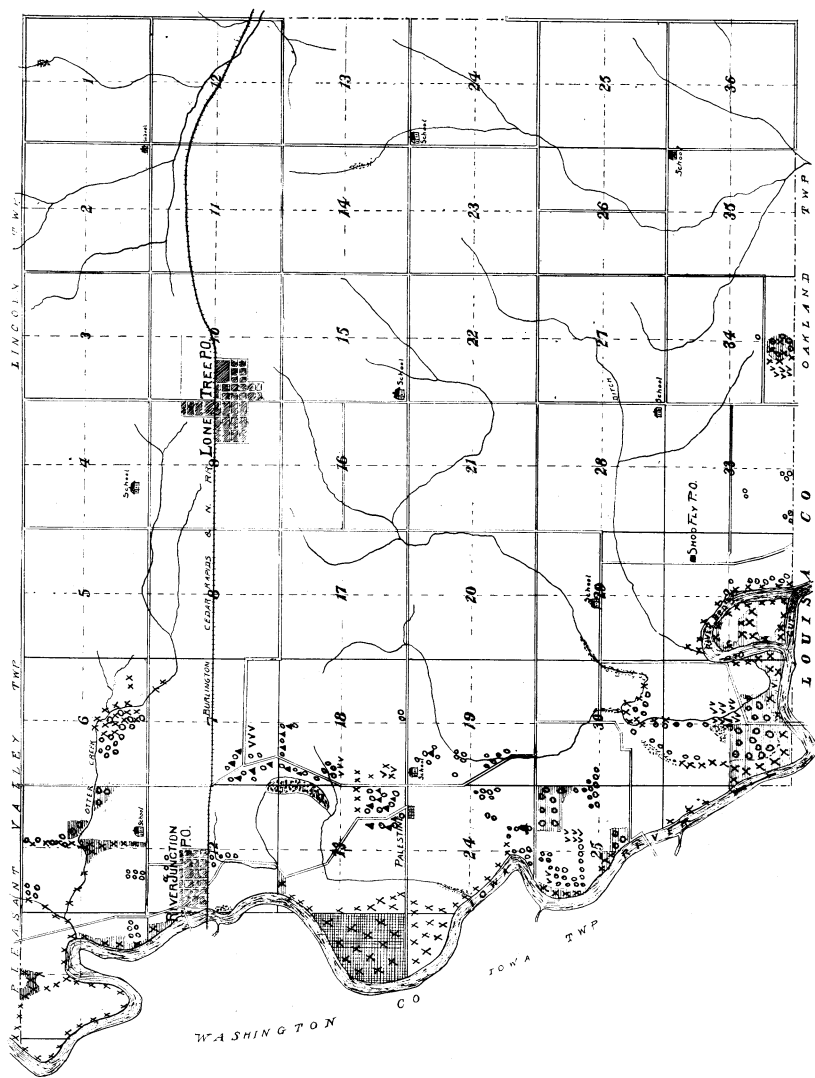


Scale 11/16 inch=one mile

LINCOLN

Township 78 North Range 5 West





Scale 11/16 inch=one mile

FREMONT

Township 77 North Range 5 and 6 West



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DECEMBER, 1918

UNIVERSITY OF IOWA STUDIES

STUDIES IN NATURAL HISTORY

Continuation of the Bulletin from the Laboratories of Natural
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VOLUME VIII

NUMBER 3

A NEST STUDY OF THE MARYLAND YELLOW-THROAT

by

NELLE E. SHAVER

PUBLISHED BY THE UNIVERSITY, IOWA CITY

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UNIVERSITY OF IOWA STUDIES IN NATURAL HISTORY

PROFESSOR CHARLES CLEVELAND NUTTING, M. A., Editor

Continuation of the Bulletin from the Laboratories of Natural
History of the State University of Iowa

VOLUME VIII

NUMBER 1

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PUBLISHED BY THE UNIVERSITY, IOWA CITY



A NEST STUDY OF THE MARYLAND YELLOW-THROAT

The present paper is based upon a continuous study of the nest life of the Maryland Yellow-throat (*Geothlypis trichas trichas*) and was made during the summer of 1917 at the Iowa Lakeside Laboratory, on Lake Okoboji.

The nest was found on the Laboratory campus, within twenty feet of the lake, on the sloping shore. It was built in a tuft of long grass between three bushes of Wolfberry (*Symphoricarpos occidentalis*) and was very effectively concealed. To the north of the nest lay an open pasture, while to its south and east was a thicket made up of the wolfberry, wild Rose (*Rosa acicularis*, wild Black Raspberry, wild Bergamot (*Monarda fistulosa*), wild Sunflower (*Helianthus cactiflorus*), and Goldenrod (*Solidago canadensis*). Overshadowing parts of this thicket were a few young trees, *e. g.*, a young elm and three young ash saplings, one of which was covered with a wild grape vine. Such an environment furnished the feeding ground for these birds during the rearing of their brood.

When found, the nest contained three eggs of the Yellow-throat and one Cowbird's egg. This was on June 27. Thereafter the nest was visited daily, and on July 8, the Cowbird egg was hatched. By 6:30 A. M. on the next day the first young Yellow-throat was in the nest and it was decided to erect the blind. By 10:00 A. M. on the same day the second Yellow-throat was out of the shell.

Work on the blind was carried on with caution in order to avoid exciting the birds unduly. But it was found that they paid very little attention and were not deterred from attending to their duties at the nest. The blind was finally erected within eighteen inches of the nest, so that the observer might look directly into the nest at very close range.

The nest was under actual observation during the following periods:

Monday, July 9	from 11:00 A. M. to 8:30 P. M.
Tuesday, July 10	from 4:30 A. M. to 8:25 P. M.
Wednesday, July 11	from 4:35 A. M. to 8:30 P. M.
Thursday, July 12	from 4:30 A. M. to 8:10 P. M.
Friday, July 13	from 4:50 to 6:22 A. M. from 7:07 to 8:12 P. M.
Saturday, July 14	from 4:27 to 11:30 A. M. from 4:10 to 6:32 P. M.
Sunday, July 15	from 4:50 to 9:55 A. M. from 1:20 to 6:10 P. M.
Monday, July 16	from 4:47 A. M. to 8:00 P. M.
Tuesday, July 17th	from 4:30 A. M. until the birds left the nest.

In order that the birds might be readily distinguished the first one to hatch was marked on the head with a red aniline dye (neutral red); the second one was marked with a blue aniline dye (methylin blue). In the following account these young will be designated "Red" and "Blue" respectively. The third Yellow-throat egg did not hatch, as will be explained later.

I wish, at this point to acknowledge my indebtedness to Professor R. B. Wylie, Acting Director of the Laboratory, for his interest in this work, and for his thoughtfulness in many ways about the camp; and to express my thanks to Professor T. C. Stephens, under whose direction the work was carried on.

TABLE I
SHOWING FEEDING ACTIVITY OF THE PARENT BIRDS

<i>Date</i>	<i>Visits</i>			<i>Percentage</i>	
	<i>Male</i>	<i>Female</i>	<i>Total</i>	<i>Male</i>	<i>Female</i>
July 9	31	9	40	78	22
July 10	62	36	98	63	37
July 11	75	35	110	68	32
July 12	87	75	162	54	46
July 13	18	19	37	49	51
July 14	54	55	109	49	51
July 15	82	78	160	51	49
July 16	187	161	348	54	46
July 17	86	84	170	51	49
Total	682	552	1234	55	45

FOOD AND FEEDING

During the first few days after the young were hatched the male did much more of the feeding of the young than did the female. This is undoubtedly explained by the fact that the duties of the female in brooding the young confined her to the nest much more closely during this period. By the fifth and sixth days the two parents shared the work of feeding about equally. Throughout the entire period, however, the male maintains the lead over the female in feeding activity by about ten per cent, as shown in figures of Table I.

Often during the first few days food was brought to the nest by the male and delivered to the female, who, in turn, apportioned it to the young. The following note from the field record of the first day: "Male brought an insect and gave it to the female. They passed it back and forth to break it up; then she gave a little of it to the cow-bird, and the rest to the Blue." Later when she heard him coming she would leave the nest, and he would do the feeding.

The feeding visits of the first three days were preceded by a little chirp. On the fourth day the parents approached the

TABLE II
SHOWING DISTRIBUTION OF FOOD TO THE YOUNG

Date	Cowbird	Red	Blue	Unknown	Total	Percentage		
						Cowbird	Red	Blue
July 9	32	11	8		51	63	21	16
July 10	73	24	21	5	123	59	20	17
July 11	82	26	26	1	135	61	19	19
July 12	105	43	40		188	56	23	21
July 13	27	10	7		44	61	23	16
July 14	63	26	26		115	54	23	23
July 15	97	47	40	1	185	52	25	22
July 16	190	100	91		381	50	26	24
July 17	99	25	39		163	60	15	24
Totals	768	312	298	7*	1385†			
Percentage	55	22	22	1				

*Occasionally, in feeding, the female got off the nest and stood between the blind and the young, so that it could not be determined which of the young were fed.

†The total shown here is greater than the total in Table I. This is due to the fact that sometimes the parent divided the food up between two or more of the young, and the feeding of each young is counted in this table.

nest silently, and unless they made some sound with the wings, we had no warning of their approach. On these first days the birds seemed to have definite paths of approach to the nest. But as the nesting period advanced this stereotyped behavior became less distinct.

The above table shows that the Cowbird received a trifle over 55 per cent of the total amount of food given during the time of observation. And this percentage is most likely indicative of the entire nestling period, since it was as high on the last day as on other days preceding.

The birds gleaned their food from the ground and the shrubbery close to the ground. The greater amount of the food for the young was such as must have been picked from the low bushes around the nest. The small moths which were so numerous in the grass, seemed to afford an unfailing source of supply (see Table III). The "worms" were the usual miscellaneous assortment of larvae, mostly with a greenish color. These were, of course, gleaned from the foliage. The number of spiders taken by these birds was an interesting fact. One who is not familiar with the habits and distribution of spiders might be surprised that so many could be found within the limited feeding range of these birds. Other members of the Laboratory who were engaged in the collection and study of this group found it quite easy to understand, however. The chief fact to be set down here is that spiders are used as food by these birds, and in great quantity. Incidentally, we may be assisted in understanding certain habits of spiders; for instance, their endowment with rapidity of locomotion, and their instinctive tendency to remain under cover of leaves, or other objects of concealment.

Sometimes the food morsel was large, and the time required by the young in swallowing made its identification possible. At other times the food was small, and the feeding process was so rapid that identification was impossible. Much of the small stuff may have consisted of plant lice, etc.

There was no evidence of regurgitative feeding at any time during the nestling period. And it will be remembered that observations began at the time the young were hatched.

TABLE III
CLASSIFICATION OF NESTLING FOOD

1. Unidentified Insects	376
2. Moths	347
3. "Worms"	290
4. Spiders	280
5. Mayflies	116
6. Flies	61
7. Unrecognized material	92
8. Caterpillars	20
9. Damselflies	54
10. Beetles	13
11. Chrysalids	13
12. Butterflies	11
13. Seeds	10
14. Caddisflies	3
15. Grasshoppers	6
Total	1694*

BROODING

Brooding at the nest was performed entirely by the female. During the first few days after the hatching of the young she was on the nest most of the time. She would, however, make short trips from the nest and bring food to the young; she may also, on these occasions, have secured food for herself. Later, she did not brood regularly during the day at all, but always did at night. However, on the last night she was not on the nest at 8:25 p. m. when the young had settled for the night, and she was not there at 4:30 o'clock the next morning. It may be then that night brooding is controlled by a separate instinct whose intensity diminishes directly with the growth of the birds.

In the early days of the brooding she would step on the birds, sit down, and fluff out the feathers. But during the latter part of the period she would stand on the sides of the nest and lean over. The sitting posture seemed to get more uncomfortable as the birds became older and more active.

*This is larger than in Table II because at times the observer recognized several insects in one feeding. This fact is not noted in Table I or II.

SANITATION

EXCRETA

TABLE IV

<i>Dates</i>	<i>Cowbird</i>				<i>Red</i>				<i>Blue</i>			
	De-		Car-		De-		Car-		De-		Car-	
	voured		ried		voured		ried		voured		ried	
	f	m	f	m	f	m	f	m	f	m	f	m
Monday, July 9	4	5			2							
Tuesday, July 10	11	7		6	7	4			5	3		
Wednesday, July 11	4	1	6	6	6	1		2	4	2		
Thursday, July 12	5	2	5	16	6	4	1	3	8	7		4
Friday, July 13			2	2	1	1				1	1	
Saturday, July 14	1		8	2	1		3	3	1	1	3	1
Sunday, July 15	1		11	7	1		7	3	2		5	4
Monday, July 16			9	20	1		9	16	2	2	5	9
Tuesday, July 17			5	5			3	1			4	3
	—	—	—	—	—	—	—	—	—	—	—	—
	26	15	46	64	23	12	23	28	22	16	18	21

Total amount disposed of (f) 158.

Total amount disposed of (m) 156.

It was interesting to observe the way in which this pair of small birds worked out the sanitary problem. On visit 336 this note was made. "Blue was last fed on visit 311, two hours and 39 minutes earlier. During this period no excreta have been voided." From this and other data we may conclude that food is the excitant which sets in motion the muscles of evacuation. The records show that it was only six times out of the whole number that the excreta sac was voided by a nestling other than the one just fed. After feeding, the parent would wait a few moments at the side of the nest; as the excreta sac appeared it would be seized and devoured, or carried away.

During the nestling period the excreta sac was voided only five times while the old birds were absent from the nest; and these all occurred in the later days of the period. It may indicate an intensification of feeding activity, or it may indicate a degeneration of the instinct governing the removal of the excreta. The following notation was made at visit 991: "Excreta were voided by Red after the female left the nest. In a moment she had returned with a small insect in her bill; she ate the insect herself and carried away the excreta." With

feedings becoming more frequent as the time passes it would seem that the former might be true.

The nest was inspected carefully every few minutes, usually by the female, and any foreign substance disposed of. Early in the nestling period she seemed dissatisfied with the interior, and would pick into it vigorously, sometimes nearly standing on her head in her efforts. The observer wondered if this behavior could be for the purpose of securing ventilation. Bits of paper put in the nest by the observer were carried away on the next visit. The nest throughout the period was kept in an immaculate condition.

REMOVAL OF THE ADDLED EGG

When the Cowbird's egg hatched a large fragment of the shell fell over one of the Yellow-throat's eggs in such a way as to fit it very exactly; and as the albumen became dry it became securely adhered. In size the fragment was equivalent, perhaps, to one third the surface area of the Yellow-throat's egg. The result of this accident was that the latter egg did not hatch, but remained in the nest until July 12 (the fifth day). Toward noon of this day the foliage overhead had been parted to admit the light for photographic purposes. The nestlings had crept to one side of the nest to escape the rays of the sun, so that the addled egg remained alone and in plain view. The male Yellow-throat came first to the nest with food. Seeing the addled egg, he picked it up between the mandibles and carried it away, without breaking it and with no slips or unsuccessful trials. The bird, carrying the egg, disappeared in the foliage of the trees at a distance of about twenty-five feet from the nest.* It is possible that the ridge formed by the shell fragment may have furnished a "grip" by which the egg was firmly held in the mandibles. On the other hand, the mandibles are capable of opening to a surprising degree, and the whole behavior of the bird in this act seemed to proceed without uncertainty or experimentation.

*The description of the removal of the egg is given by Dr. Stephens, who occupied the blind at the time of its occurrence.

Not far from this Yellow-throat's nest there was a Yellow Warbler's nest which retained an addled Cowbird's egg after the nestling warblers had left the nest. During the summer of 1914 a study of nest of the Western Meadow Lark was carried on at the Laboratory; and an addled egg of this species remained in the nest throughout the brooding period. The question arises, then, as to what is the common practice of birds toward foreign egg in the nest, or toward an addled egg.

THE COWBIRD

The manner in which a portion of the shell of the Cowbird's egg became adhered to one of the Yellow-throat's eggs, preventing the latter from hatching has just been described. Thus 33 1/3 per cent mortality may be directly charged to the presence of the Cowbird. It will also be recalled that the Cowbird's egg hatched a day before any of the Yellow-throat's thus giving him a considerable advantage.

The Cowbird was larger to begin with, and was able to lift his head higher when the old birds came with food. In Table II the facts show that the Cowbird received fifty-five per cent of all the food brought to the nest. He seldom was satisfied, and only a very few times did he fail to thrust his head forward for food. As he got older he acquired a habit of spreading his wings, and bringing them down over the Yellow-throats. Sometimes they retaliated by climbing on top of him, thus gaining some advantage in position. By the 14th the young were very much crowded, and the nest walls were being pushed out. From now on there was more or less piling up of the young birds.

The 16th was the last entire day of feeding of the nestlings, and it was a very busy one for the old birds. During the daylight hours they made a total of three hundred and forty-eight visits to the nest with food. This was an average of one feeding visit every 2.6 minutes. The Cowbird received all, or part, of the food on one hundred ninety of these visits.

The eyes of the Cowbird opened on the fourth day; on the sixth he began to stretch and preen his feathers; on the eighth

he was quite active; and on the ninth he left the nest; though he was preceded by the other young birds.

THE YOUNG YELLOW-THROATS

On the third day (*i. e.*, on July 12) it was noticed that the young Yellow-throats uttered a faint twitter on the approach of the parents; this was stronger and more musical by the fifth day (July 14). On the 16th it was recorded that "Red stood up in the nest and scolded when the Cowbird was fed." Early in the feeding period we felt that these birds might not be getting enough food, but as the days went by their gain was noted. By the 16th they were well able to compete with their larger companion as the above shows.

On the 17th the foliage above had been parted for some time to allow the sunlight to reach the nest in order that pictures might be taken. The young birds did not like the heat of the sun, and would work over to the edge of the nest in search for shade. No doubt their departure from the nest was somewhat premature on account of this. At any rate at 9:01 A. M. Red got on the edge of the nest, and after a moment's hesitation, he hopped to a stick about six inches away. As soon as the mother bird returned to the nest, she seemed to urge him to venture farther on his journey.

In the meantime some excitement caused among the birds by the appearance of a chipmunk, at which time Blue left the nest in much the same manner. Both birds, when they left the nest, were fairly well feathered out on the wings and back; and the breast was covered with a golden down. In July 20 one of the small birds was seen; and on the 27th the mother bird was seen in the vicinity with food in her beak.

EXPLANATION OF PLATES

PLATE I—

- Fig. 1. View of Maryland Yellow-Throat habitat, with blind in position at nest.
- Fig. 2. View of blind at nest showing woodland background, and prairie foreground.
- Fig. 3. View of blind at nest showing lake background and prairie foreground.

PLATE II—

- Fig. 1. View of nest showing location in a tuft of grass, latter parted to reveal nest.
- Fig. 2. Nearer view of nest showing three eggs of the Yellow-throat, and one of the Cowbird.

PLATE III—

- Fig. 1. Male Yellow-throat feeding young in nest.
- Fig. 2. Female Yellow-throat feeding young. The variation in path of approach to the nest by the two parents, as indicated by their positions in the figures of Plate III, was quite uniform and constant.

PLATE IV—

- Fig. 1. Male Yellow-throat removing the excreta sac from one of the young.

PLATE I

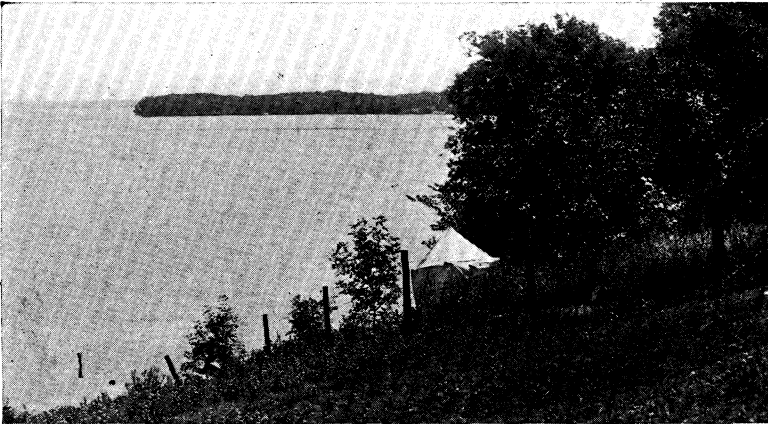


FIGURE 1



FIGURE 2

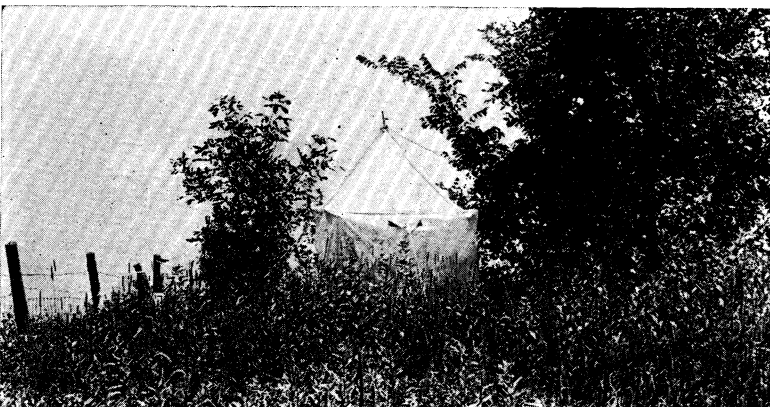


FIGURE 3





PLATE II



FIGURE 1



FIGURE 2



FIGURE 1



FIGURE 2





PLATE IV



FIGURE 1





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Continuation of Bulletin from the Laboratories of Natural History of the
State University of Iowa

VOLUME VIII

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BARBADOS-ANTIGUA EXPEDITION

by

C. C. NUTTING

PUBLISHED BY THE UNIVERSITY, IOWA CITY

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PROFESSOR CHARLES CLEVELAND NUTTING, M. A., Editor

Continuation of Bulletin from the Laboratories of Natural History of the
State University of Iowa

VOLUME VIII

NUMBER 3

BARBADOS-ANTIGUA EXPEDITION

NARRATIVE AND PRELIMINARY REPORT OF A ZOOLOGICAL
EXPEDITION FROM THE UNIVERSITY OF IOWA TO THE LESSER
ANTILLES UNDER THE AUSPICES OF THE GRADUATE COLLEGE

by

C. C. NUTTING

PUBLISHED BY THE UNIVERSITY, IOWA CITY

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PREFACE

This work is intended as a companion volume to the "Narrative and Preliminary Report of the Bahama Expedition From the State University of Iowa," published in 1895. The Barbados-Antigua Expedition, like the Bahama Expedition, was somewhat of an experiment, although the general aims of the two were much alike and the number of persons constituting the party was almost the same, being twenty in the Bahama Expedition and nineteen in the one described in the present work.

The two differ, however, in the following particulars: (1) Instead of living on shipboard as on the Bahama Expedition, the Barbados-Antigua party made their headquarters ashore; and from these bases explored the surrounding reefs and shores by means of row-boats, and dredged down to about 150 fathoms with a 27-foot gasoline launch. (2) More attention was given laboratory work under these conditions than would have been possible on shipboard, and more pains were taken in the killing and preservation of specimens by the refined methods that have been devised during the past twenty-five years. (3) The average age and experience of the Barbados-Antigua party was considerably greater than in the case of its predecessor, nearly all of the members being either instructors or graduate students in zoology or professional naturalists of recognized standing. (4) The photographic equipment was much better than was available twenty-five years ago, and included a good outfit for making motion pictures and a professional operator of exceptional ability.

Owing to the numerous explorations which have been made in West Indian waters during the past quarter of a century, the number of new forms which will be described in the various reports of the Barbados-Antigua Expedition will doubtless be much smaller than in the case of the former expedition, and this difference will be still greater from the fact that the Lesser

Antilles are by no means such a rich field as the region about the Bahama Islands, Cuba, and the Florida Keys, particularly the Pourtalés Plateau. Moreover, the amount of dredging in water over 100 fathoms deep was much less, and hence the deep-sea novelties are by no means so conspicuous as those described in the various reports on the Bahama Expedition.

On the other hand, very little work of any kind has been done at Barbados and Antigua, and our party brought a quantity of material from these islands which will, most of it, add to our knowledge of the geographical distribution of marine life.

The expedition is indebted to numerous friends for aid of various sorts, acknowledgment of which will be found in the following pages; but the writer deems it proper to mention here a number of friends who have rendered particularly valuable service.

To President Walter A. Jessup of the University of Iowa and Dean Carl E. Seashore of the Graduate College we owe our thanks for their whole-hearted backing from the very first. Senator William S. Kenyon procured credentials from the British ambassador and our Secretary of State. To Sir Francis Watts, K. C. M. G., Imperial Commissioner of Agriculture for the British West Indies, we owe our gratitude for most efficient aid, both in connection with the preliminary trip to Barbados undertaken by the writer, and in securing the excellent quarters for the party at Pelican Island and English Harbor, as well as for much valuable advice. Mr. John B. Henderson of Washington, D. C., made dredging possible by the use of his launch fully equipped, and the services of his engineer, Captain Greenlaw. Dr. Paul Bartsch and Dr. Austin H. Clark of the United States National Museum aided us with valuable advice and suggestions.

The Quebec Steamship Co. was generous in its concessions in the matter of transportation for the members of the party and our equipment and collections, a most perplexing problem in time of war. To the Colonial authorities at Barbados our thanks are due for ample quarters and aid of various sorts. His Excellency, Sir Leslie Probyn, Governor of Barbados, extended valuable courtesies; and his successor, Governor T. C. Fell, did everything in his power to make the exposition a success and was our steadfast friend throughout. Colonial Secretary Phil-

lips very kindly transmitted to us his daily copy of cablegrams regarding the progress of the war. Mr. James Sanderson, Clerk of the Board of Health, did much to make us comfortable on Pelican Island. To the officials of the Colonial Department of Agriculture, in charge of Mr. J. R. Bovell, we are indebted for numerous courtesies. Mr. Arthur Gill aided us very efficiently with his intimate knowledge of the reefs and waters about Barbados, as well as in our dealings with the fishermen of the region.

The numerous personal courtesies extended our party are acknowledged in the following pages. We cannot refrain, however, from referring to the innumerable kindnesses, both official and personal, of the United States Consul, Hon. C. L. Livingston, and his wife.

At Antigua His Excellency, Acting Governor T. A. V. Best, was untiring in his official and personal courtesies. It is largely to him that we owe our comfortable quarters at English Harbor, while he and the other Colonial officers made it possible for our equipment to be entered free of duty, the usual customs formalities being waived in our behalf. Mr. A. E. Collens, Government Chemist, acted as our advance agent in preparing our quarters and was untiring in his friendly interest throughout our stay. Rev. Hal Shepherd advised us regarding local conditions at English Harbor and gave much valuable information regarding the flora of Antigua. Colonel Bell and Captain Downing in command of the Defense and Police Forces, gave us every facility in the matter of photography, including a review of the Police and Defense Forces for the purpose of securing a motion picture.

The members of our party enjoyed the courtesies and hospitality of many of the residents of Antigua, and our geologist and entomologists were materially aided by the advice of several gentlemen locally interested in scientific matters, acknowledgment of which is made in the text. Special mention, however, is due the very efficient and constant services rendered by Mr. Lake, the caretaker at the Dockyard, who aided us very materially in the matter of dealing with the servants and local population.

Unless otherwise indicated, all of the illustrations in this volume are from photographs taken by Maurice Ricker, official photographer of the expedition.

The author is under great obligation to Professor H. F. Wickham for his patience and care in reading the proof of this volume.

C. C. NUTTING

University of Iowa,
May 5th, 1919

CHAPTER I

PREPARATION

Twenty-five years ago the "Bahama Expedition" from the University of Iowa attained a gratifying success.* It not only furnished a life-long inspiration to the twenty members of the party and contributed substantially to our knowledge of the region visited, but it also supplied valuable material for class-room work for a full quarter of a century.

From that time to this numerous expeditions have gone forth from the University, covering the North American continent from the Arctic coast to Costa Rica and from Maine to California and still westward to mid-Pacific. Each has been successful and each has added its quota to the scientific equipment of the University. None, however, had included so large a party nor proposed so ambitious a program as the "Bahama Expedition," until the Barbados-Antigua Expedition was proposed and carried to a successful conclusion.

The proposal came from two sources. In the first place President Jessup of the University had suggested that it was "about time for another Bahama Expedition." In the second place, certain members of the Zoology Club of the University flatly put the question to the writer "Can't we have another expedition along the lines followed by the one of which we have heard so often, and thus secure another lot of good zoological material?"

There was no dodging such an inquiry put formally and directly. It was a case like that of the celebrated parrot that "talked too much." The writer having been guilty of repeated lectures and references to that enterprise of more youthful days, and having impressed it upon generations of classes with lantern-slides and specimens labelled "Bahama Expedition," found himself unable to side-step when face to face with a representative committee of his most progressive students. He

*Narrative and Preliminary Report of the Bahama Expedition, by C. C. Nutting. Iowa City, Iowa, January, 1895. This work has been long out of print.

thus became committed to the organization and leadership of an undertaking involving more responsibility and anxiety than could be realized by anyone who had not been a director of a group of young men and women going to foreign lands under the conditions presented by a world war.

It must be confessed, however, in all frankness, that had I been aware of the fact that the proposed expedition would be carried on under war conditions, and had a prophetic vision been vouchsafed me of the innumerable annoyances and vexations, not to say dangers due to raiders and U-boats, it is doubtful whether the project would have been entertained. It should be distinctly understood that the proposition was made before there seemed to be any likelihood that the United States would be drawn into maelstrom of a world war.

Having thus committed ourselves to a serious consideration of the proposed expedition, the first matter for discussion was the question as to where to go. The Bahama Expedition had worked in the region of the Bahama Islands, Cuba, and the Florida Keys—the westernmost of the West Indies. It was but natural, therefore, that our thoughts turned to regions somewhat remote from the former field and yet it was desirable to have the two fields somewhat similar as to general conditions, so that the expeditions could be logically connected up as separate but distinctly related enterprises.

In order to get information from those whose experience enabled them to speak with authority, the writer took occasion to go to New York in connection with the meeting of the American Association for the Advancement of Science in December and January, 1916-17, where he had an interview with his old friend Dr. A. G. Mayer, Director of the Carnegie Marine Biological laboratory at the Dry Tortugas, and one of the best informed men in America on all subjects relating to marine biological work. Dr. Mayer was helpful and sympathized with the project, as might have been expected. He made two suggestions as to the field of proposed work. One was Montego Bay, Jamaica, where he thought that quarters formerly used by the Carnegie laboratory could be secured. It seemed, however, that this region had already been fairly well worked and was moreover rather too near our former sphere of activities.

The other place suggested was our new possessions in the Danish West Indies. This region, as a matter of fact, proved to be devoid of proper accommodations for so large a party as ours.

Upon visiting Washington on business for the United States National Museum, the writer was so fortunate as to make the acquaintance of Dr. Austin H. Clark, who promptly urged the claims of Barbados as a base for our operations. This island is the easternmost of the West Indian chain, which stretches in an arc of over two thousand miles between North and South America. It seemed that some interesting problems of geographic distribution might be solved there. At any rate, almost every species taken with the dredge or tangles would be the basis of a new locality record and fill an important gap in our zoological knowledge of the West Indian region. He represented the climate as healthful and the attitude of the colonial authorities friendly, statements of which both have been amply verified.

Dr. Clark also put us in communication with Sir Francis Watts, Imperial Commissioner of Agriculture for the British West Indies, a man whose scientific acumen and knowledge of the region is surpassed by no one, so far as I am aware. This was a fortunate introduction for us and resulted in our securing the most influential and intelligent helpfulness that could be imagined.

At this time I also had the pleasure of meeting another man who was destined to be invaluable to the success of our undertaking, Mr. John B. Henderson, one of the Regents of the Smithsonian Institution, an enthusiastic naturalist particularly interested in the Mollusca, who had collected extensively in Cuba, the Bahamas, and Florida Keys. Mr. Henderson had, moreover, worked out an admirable equipment for dredging with his launch down to two hundred fathoms, and had published an unusually interesting volume on marine work off Cuba "The Cruise of the Tomas Barrera," which I had read with great pleasure. As we shall learn, he ultimately became a member of the Barbados-Antigua Expedition.

Upon my return to Iowa City and reporting upon the information gained in the east, the Zoology Club was enthusiastically

in favor of going on with our preparations. The scheme may be said to have been formally inaugurated at a dinner given on January 22, 1917, in which most of the persons who eventually made up the party participated.

President Jessup warmly espoused the project and Dean Carl E. Seashore of the Graduate College proposed that the financing of the Expedition be undertaken by his college, stating that such a project was distinctly suitable for graduate work and quite the sort of thing for which he personally stood.

With such excellent backing, public announcement of the undertaking was made and applications for membership began at once to come in. As in the case of the Bahama Expedition, we were at once confronted with the question as to the admission of women to our party, and the old argument that this was a coëducational institution was forthcoming. Ultimately precisely the same number were admitted as in the case of the former expedition, namely, seven. Correspondence was entered into with Sir Francis Watts and others, and charts were secured from the United States Hydrographic Office of Barbados, the Virgin Islands, and some other of the Lesser Antilles.

Previous experience having proved the absolute necessity of someone's going to look over the ground, the writer consented to take a preliminary trip to the region under consideration in order to spy out the land and report on a definite plan for the proposed expedition. Application was made to the Quebec Steamship Company for information concerning their West Indian cruises. The steamers of this company call at a number of the islands and furnish better opportunities for their survey than any other line. Their officials are disposed to be generous whenever scientific parties desire to avail themselves of the facilities offered by the West Indian service.

Advices from the Imperial Department of Agriculture indicated the hearty support of its officials and gave much desired information regarding Barbados as a suitable base for operations. Senator W. S. Kenyon of Iowa was most helpful in securing credentials from the Department of State and the British ambassador at Washington. These letters were of very great service when it came to dealing with the Colonial authorities.

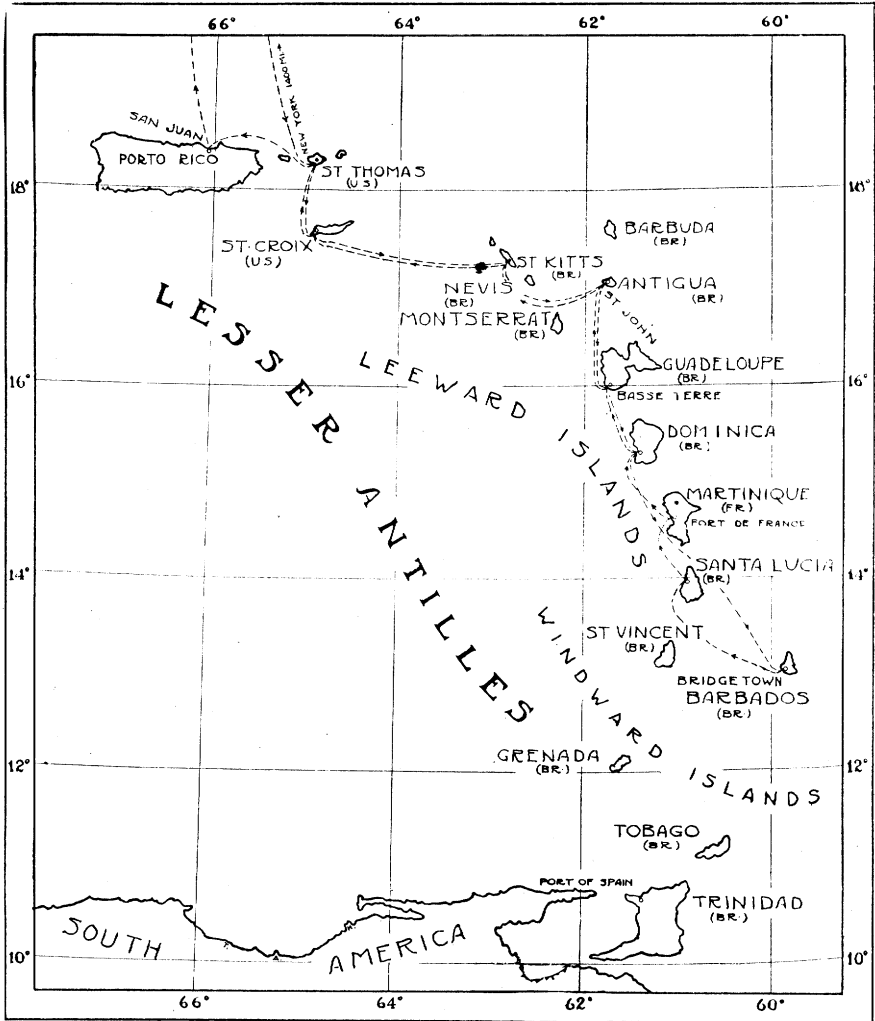
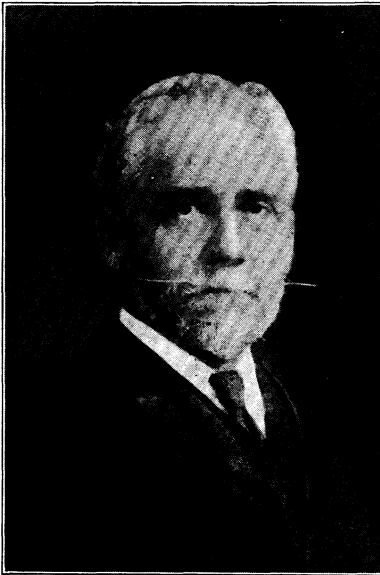


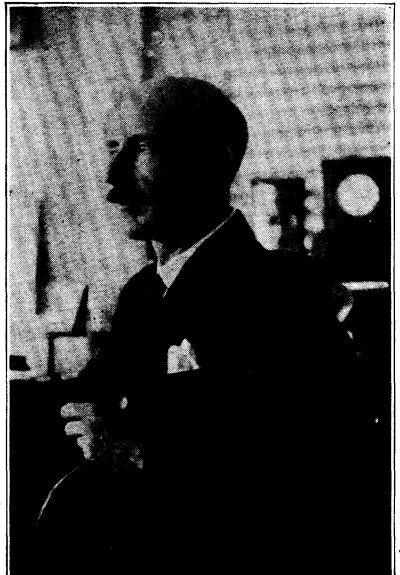
Chart of the Lesser Antilles, showing route of Expedition (adapted from Century Atlas)



PLATE II



Sir Francis Watts, K. C. M. G., Imperial
Commissioner of Agriculture, British West
Indies (See page 11)



His Excellency T. A. V. Best, Acting Gov-
ernor of the Leeward Islands (See
page 38)

In the midst of these preparations came the declaration of war by the United States! Of course we knew that events were shaping themselves in this direction, but we were hoping against hope that the German government would not insist on making an additional enemy of our country. Having definitely committed himself to the carrying through of the proposed expedition, the writer followed his customary course of going ahead with an undertaking until he is stopped; a state of mind considered perseverance by friends and regarded as pig-headedness by the unfriendly. He accordingly decided to go on with the preliminary trip at any rate, a decision in which he was encouraged by University authorities and members of the party.

On June 16, 1917 I sailed from New York on the steamer "Parima" of the Quebec Line, not greatly heartened by the war color of the vessel nor by the absence of lights at night. Lights have always been associated with the idea of safety at sea; and their absence was, to say the least, depressing.

A six days' sail brought us to St. Thomas, one of the possessions recently acquired from Denmark. Although there is doubtless good collecting around this island, it soon became apparent that there were no available quarters for so large a party as ours bade fair to be.

St. Croix, or Santa Cruz, the next island visited, although sufficiently attractive from a scenic standpoint, and possessing inviting coral reefs, offered the same difficulties. Mr. Smeigelow, a Danish gentleman who managed a very extensive sugar plantation, took me over the island in his automobile, on roads that were as good as city boulevards, and through enchanting scenery. He offered to find accommodations for us in houses owned by him and at a very reasonable rate, but the expense of fitting them up for our purpose would have been considerable and moreover they were quite an appreciable distance from the sea.

St. Kitts, the first of the British Islands, came next. It seemed that each island was more beautiful than the preceding and one wanted to stay over at each of them, had time permitted. From our standpoint, however, we could see very little that was particularly inviting to the marine zoologist in this beautiful island.

Antigua came after St. Kitts. I had become acquainted with a Dominican planter named Sowray as a traveling companion, and an unusually fine fellow he was. He was the first to suggest English Harbor, Antigua, as an excellent base for our enterprise. Although I went shore at Antigua, English Harbor was not visited at this time, and I was not particularly impressed by the hurried visit to St. John's, the capital.

Dominica, although a veritable paradise for the land naturalist, has neither good roads nor accommodations for a large party. In spite of this fact, it is to my mind the most beautiful of all the Lesser Antilles that I have seen. It is more intensely tropical in appearance than any of the others, owing to its lofty mountains that induce an excessive rainfall and produce its innumerable mountain streams and picturesque waterfalls.

The French Islands, Guadeloupe and Martinique, are almost equally beautiful and offer an interesting variety of language and customs of peculiar charm to the tourist. But for our purpose it was best to avoid regions where the mother-tongue is not used, and these islands were not seriously considered.

On the morning of Friday, June 29th, the "Parima" cast anchor in Carlisle Bay, Barbados, and the outward voyage, so far as I was concerned, was most pleasantly ended. Sir Francis Watts, having received notice by cable of my being on the "Parima," sent a man aboard with a most friendly note of greeting and with instructions to see that my effects and self were safely landed and passed through the custom house.

I had agreed to do some collecting both for the University and for the National Museum, mainly for the purpose of sampling the fauna, as it were. Thanks to the friendly offices of Sir Francis Watts, there was no trouble or formality whatever at the customs, and I soon found myself ashore at this the easternmost of the chain of West Indian Islands.

About two weeks were spent here in becoming acquainted with the Colonial officials and others who could aid me in gaining information as to the suitability of the island for zoological work. Thanks to my credentials, plus the personal introductions and counsel of Sir Francis Watts, I met with courtesy and helpfulness on all sides. I collected with the help of divers off Hastings and spent nearly a week in this work off the Crane

and Lord's Castle. This method of prospecting the fauna down to ten fathoms was interesting and profitable, the negro divers being very expert, indeed the best I had ever seen. One of them, Albert Ashby, proved exceptionally good; one of the strongest, most willing, and most intelligent men that I have ever employed. We shall hear much more of him later.

The day before I left, Mr. Arthur Gill, a yachtsman and admiralty official, took me in a boat to inspect some particularly fine reefs off the southern coast. As we were returning he called attention to Pelican Island, where the Quarantine Station was located, although it had not been necessary to use it as such for several years. He remarked that this would be a fine place to secure quarters for our party, a remark that eventually led to important results, as will be seen.

As a matter of fact, I had been most favorably impressed with the salubrity of Barbados, the kindly attitude of the officials and the luxuriant fauna about the reefs. But a serious difficulty presented itself in the dense population of negroes that occupied the entire island, the most congested population in the western hemisphere. The guide book put it at 196,000, or 1,180 to the square mile!

Imagine the difficulties that would be encountered by a rather large party of strangers from the far-away United States doing a lot of most unusual and inexplicable things and with a laboratory equipment of mysterious instruments most alluring to the child-like mind of these natives! Without any hostile intent whatever, impelled solely by friendly curiosity, they would inevitably crowd about us at all times and the children and babies would be continually under foot. It therefore seemed hopeless to secure suitable working conditions along the shores populated by this swarm of curiosity-impelled natives, where privacy would be out of the question.

But if such a place as Pelican Island could be secured, the worst of our difficulties would be solved. The buildings were substantial and ample to accommodate a much larger party than ours, and laboratory space would be much more than adequate for our needs. Good, thriving reefs were abundant for miles in the immediate neighborhood; and, best of all, being on govern-

ment property and on an island, we would be entirely isolated and thus avoid the intrusion of the swarming population.

Before I left I found that several of the influential officials, including Dr. Johnston of the Board of Health, would approve this concession in our favor if a formal request were made by the University authorities.

Sir Francis Watts, who was called on official business to Antigua shortly before my visit to Barbados was ended, urged me to consider the availability of English Harbor for such an expedition as ours; and when we dropped anchor in St. Johns Harbor, Antigua, on the return trip, he sent me a note on the government launch urging me to come ashore, as he wanted to take me over to English Harbor with him. An automobile awaited us at the landing, and Mr. Collens, government chemist, stationed at St. Johns, accompanied us on the delightful ride across the island to English Harbor. After a brief inspection of the immediate surroundings I became quite as enthusiastic an admirer of this historic and beautiful spot as was Sir Francis. The buildings at the old dockyard, as is usually the case where Britain does the work, were of massive stone and brick construction, although old and unoccupied for generations except sporadically for summer encampments of the Antigua Defense Force. The Officers' Quarters were commodious and cool, and there was any amount of room for laboratory uses. A stone seawall surrounded the dockyard on three sides, and there was such a display of marine life as would be hard to match anywhere else, the most conspicuous being an immense aggregation of huge serpulid worms with wide-spread tentacle crowns a foot across when fully expanded. A half hour's inspection convinced me that here was an ideal spot for collecting and laboratory work, and Sir Francis believed that the Colonial Government would place it at the disposal of our party.

Antigua is surrounded by almost innumerable reefs and islets, and indented with deep bays, offering an exceedingly broken coastline and hence great variety of habitat for shoal water forms. There is much more to attract the land naturalist than at Barbados, and the human population is relatively scanty, considerable areas being original jungle with practically undisturbed flora and fauna.

The trip home from Antigua was uneventful, excepting a piece of good fortune encountered in Washington, when Mr. John B. Henderson expressed a desire to accompany the expedition and take along his launch and its equipment; together with Captain Greenlaw, who had for years acted as his skipper on various dredging expeditions to the Bahamas, Cuba, and the Florida Keys. The question of a suitable launch for dredging had worried us not a little. There appeared to be but one boat that would do for our purpose at Barbados, and that was sold to other parties before our visit there. We heard of nothing that appeared suitable at Antigua. Even if there could be found a launch that would do, prices had risen so as to be prohibitive, and the matter of equipment in war time would either be exceedingly expensive or utterly impossible. It will therefore be easy to appreciate my feeling of relief at Mr. Henderson's exceedingly generous, although tentative, proposition, which at that time was merely indicative of a strong desire on his part that might, or might not, materialize later.

Upon my reporting at Iowa City, the members of the party decided to divide the time of the expedition between the islands of Barbados and Antigua, provided that quarters could be secured at Pelican Island and English Harbor; formal requests from President Jessup to the Colonial authorities resulted in these quarters being generously placed at our disposal free of charge. These very material concessions, with many others, we owe mainly to Colonial Secretary (now Governor) Fell of Barbados and his Excellency, Governor T. A. V. Best of Antigua. Sir Francis Watts was also very helpful in both cases.

And now we were confronted by the question:—Should such an undertaking be carried out under war conditions? The University authorities took the position that those of us who could not engage directly in war activities should do all that we could to further the interests of our several departments. Previous experience had shown that the cheapest and best method of securing material in the natural sciences for both undergraduate study and graduate research was to go for it and obtain it in quantity, at the same time gaining the experience of permanent value to teachers of studying specimens alive in their natural surroundings. Moreover, President Jessup and Dean Seashore agreed that, having secured the very considerable concessions

from the Colonial Governments and the Quebec Steamship Company under the implied agreement to undertake the proposed expedition, we were under considerable moral obligation to carry out the undertaking unless prevented by obstacles too serious to be overcome.

As to the individual members of the party, each was expressly informed that the director would take no personal responsibility whatever of their going under war conditions. Each was to be wholly responsible for himself or herself, the director agreeing of course, to do all in his power to carry the expedition through to a successful issue.

After careful consideration, it was finally decided to go on with the project, President Jessup and Dean Seashore heartily concurring; and so the Barbados-Antigua Expedition became a definite undertaking, and we at once set about maturing our plans. Much preliminary work had already been accomplished by the trip undertaken by the writer. The necessary contact with the men on the ground had been definitely made. Sir Francis Watts had agreed that his Department of Agriculture at Barbados would act as advance agent for us in making preliminary arrangements regarding quarters, servants, etc. He also advised us that Mr. A. E. Collens at Antigua, an official of the Imperial Department of Agriculture, would act in a similar capacity at that island; and I wish here to acknowledge our very great obligation to Mr. Collens for the efficient manner in which he looked after our interests at the expense of much time and trouble for which he received no recompense whatever.

Meetings of the Zoology Club were held each week, at which our plans were discussed and various committees appointed. These committees were as follows: Executive Committee, C. C. Nutting, Professor H. F. Wickham, and Professor F. S. Stromsten. The two first mentioned had been members of the Executive Committee of the Bahama Expedition twenty-five years before. Professors Wickham and Stromsten were unable to accompany the party for reasons beyond their control, and Professor A. O. Thomas and Mr. Dayton Stoner took their places in the expedition some time before leaving Iowa City.

The "Committee on Care of Collections" was under the chairmanship of Mr. Dayton Stoner; who also acted as treasurer of

the party, so far as funds contributed by the membership was concerned. The "Committee on Quarters" was under the direction of Mr. H. J. Wehman; the "Committee on Laboratory" had Dr. Thesle T. Job as chairman; a "Committee on Dredging and Equipment," acted under the leadership of Mr. John B. Henderson. Miss Gertrude Van Wagenen was chairman of the "Committee on Commissary;" and Professor A. O. Thomas took charge of the "Committee on Transportation."

Some members of the party dropped out for various reasons, but others were promptly added, and there was considerable shifting of the membership of the committees; but the chairmen mentioned above served for some time previous to sailing as well as during the actual work in the field. Shortly before our departure one member dropped out in a rather startling way. One evening the party had a sort of social gathering and supper together with various enjoyable "stunts." One young man, who was a general favorite because of his quiet dependability and enthusiasm regarding the expedition, seemed to enter into the spirit of the undertaking with more than ordinary zest. He left rather early in the evening after paying quite a considerable cash assessment to meet some preliminary expenses; went home, talked with his mother quite cheerfully about the expedition, bade her goodnight and then disappeared utterly from our knowledge, very greatly to the distress of his mother and family! Months afterwards when we were at Barbados we heard that he had obeyed a sudden impulse to enlist in the navy without consulting or intimating his project to anyone.

This incident cast a gloom over our party for the time being, but a good substitute was soon found to take the place of the missing man.

We were certainly a busy lot of people during the autumn, winter, and early spring of 1917-18. The number of details to be attended to for such a party is simply astounding. Fortunately, Mr. Henderson took upon himself all matters concerning dredging operations and the fitting of his twenty-seven foot launch "Eolis Junior." This equipment, the result of his own long experience in such work, was the most effective that I have ever seen for successful dredging down to a depth of about two hundred fathoms. The launch was built on good lines and

was very staunch and seaworthy. This equipment is of such interest to marine naturalists that a somewhat detailed description will be of use to anyone contemplating similar work.

The launch is about twenty-seven feet over all. The dredging drum is geared to the fly-wheel shaft by cog-wheels and bicycle chains which can be engaged by a lever. The drum is immediately abaft the engine and around it is wound the steel plow-wire rope leading to a davit attached to the starboard side of the boat and stayed by guy-ropes leading fore and aft. From the davit is hung the pulley through which the dredging wire passes. The great trouble heretofore has been the difficulty of dredging by backing the boat. When the dredge is caught on the bottom and a strong current is encountered there is often great trouble in circling around the dredge and getting it up without parting the wire or tripping the dredge. If the wire is passed over the stern and the dredge towed aft there is danger of the propeller striking the wire with disastrous results.

These dangers are minimized by Mr. Henderson's plan by which the dredging wire can go neither too far forward nor too far aft in the region of the propeller. A strong line is belayed to a post near the center of the forecastle deck just in front of the cockpit, and at the free end of this line a small pulley is lashed through which the dredging line, after running through the pulley just under the davit, is passed. This line can be shortened or lengthened at will by taking in or letting out at the post. While the dredge is down and the boat running forward the line is shortened, bringing the pulley end forward over the rail near the bend of the bows on the starboard side. This brings the dredge under control. If it caught on the bottom, the boat can circle around while still entirely under control and disengage, or, if necessary, trip the dredge. When the latter is clear of the bottom, the line is lengthened so that the pulley at its end comes almost directly under the pulley suspended from the davit allowing a direct pull on the dredge until it comes up high enough to be drawn inboard and its contents dumped and examined. The larger objects are then picked out and assorted while the mud, gravel, or sand is shoveled into a square sieve placed on the deck immediately aft of the cockpit. Water is played in the sieve through a hose connected with

the pump, the finer sand and mud is washed away and the smaller mollusks can be picked out, while the remainder of the sand is placed in canvas bags to be picked over carefully after it is dry. In this way many minute mollusks and Foraminifera, etc. are saved; and these often prove to be of greater interest than the larger things.

Tangles such as described in the narrative of the Bahama Expedition, but smaller on account of the comparatively small size of the boat used, were also employed. They are particularly available when the bottom is rocky, in which case the employment of the dredge is impracticable. Some good hauls were made by the use of these tangles; but it may be said that on this cruise the dredge gave better results, perhaps owing to the skill in its use which long practice had given Mr. Henderson and Captain Greenlaw. In regard to the latter, it is but just to say that he is by far the most expert man in the management of such a launch and equipment that I have ever seen. He could go out by himself and do the whole thing unaided and most successfully, managing the launch and dredge with the most consummate skill. Moreover, he kept his head in case of sudden emergency in a manner that evoked the admiration of our entire party. He was absolute master of his engine and a wizard in making it behave itself under all circumstances.

The Committee on Care of Collections had for its duties the kind and quantities of the various containers that would be needed, the preservatives to be used, labels of various sorts, and instruments for collecting aside from the dredging equipment. Twenty-four ten-gallon galvanized iron tanks with screw tops, placed in solidly constructed wooden boxes with iron handles were prepared for the bulkier "wet" material to be kept in alcohol or formalin. On the outward voyage these were exceedingly useful for carrying a good deal of our equipment, instruments, etc. Besides these we took four chests devised by Dr. Paul Bartsch of the United States National Museum. These were strongly built with two tiers of square bottles fitting into corrugated pasteboard compartments similar to those used in transporting eggs. Each box contained one hundred eight of these square bottles, somewhat over five inches high, and the whole arrangement worked admirably, hardly a bottle being broken.

We also took along a quantity of other bottles, mostly of small sizes, including a stock of homeopathic vials. These were wrapped and packed in wooden boxes of various sorts, nearly all of them coming through intact. We made a mistake, however, in not taking a quantity of Mason jars, thinking that they could be purchased at the excellent stores in Bridgetown. This we found to be an error, as very few were to be had and the price was outrageously high.

For preservatives we depended, of course, upon alcohol and formalin, taking a fifty gallon barrel of the former and over one hundred pounds of the latter. As a matter of fact, we took too little of each, but managed to patch out by local purchases.

The square pans which we found so useful in connection with the Bahama Expedition were provided for the present enterprise. These were made of galvanized iron, in pairs, the rim of one being larger than the other so that the latter could be inverted over the former and their rims soldered together. After specimens are hardened a few days in alcohol, they can be heaped in the lower pan, a little packing wet with alcohol being added; the alcohol contained in the specimens and packing being sufficient to preserve the contents which are hermetically sealed in the pairs of pans. As a matter of fact, we used only a few of the pans in this way. They were exceedingly useful in another way, however, being very handy as receptacles for assorting specimens when parties returned from collecting either with the launch or in shallow water; in placing specimens to harden and for various laboratory purposes. They nest easily for transportation and are really indispensable in the outfit of such an expedition. Dr. Fisher remarked that they were the most useful part of the equipment.

Chemicals for special methods of killing and preserving for later histological studies were included in the work laid out for the Committee on Laboratory.

Of course a great quantity of labels were taken along, both for dredging and shore stations. These were printed on good stiff paper and all bore the legend "Barbados-Antigua Expedition." Many of them were perforated at one end for a string by which they could be tied to specimens, this string being of

very strong linen or flax. The Zoology Club spent many hours in tying these strings to the labels and thus saved time and expense. We found that we had a larger number than was necessary, as the proportion of specimens to which labels could conveniently be tied was not so great as we had anticipated.

A number of dip-nets were fitted to the ordinary crab-net handles and were found useful on some occasions, especially when collecting with submerged electric light. There is a difficulty in securing actively moving animals with these nets. If the meshes are large the smaller things escape, while if they are very fine the net cannot be forced through the water fast enough to catch swiftly moving organisms.

A soldering outfit consisting of a blow-torch and irons was taken along, as well as ordinary tools such as hammers, hatchets, saws, screw-drivers, etc. Wrecking irons with a curved claw at the end were useful in breaking loose coral rocks and overturning large stones. Mr. Stoner took with him an entomological collecting outfit, and Professor Thomas was provided with a geological kit.

The Committee on Quarters secured information regarding accommodations at Pelican Island, Barbados, and the furniture that could be obtained there. Through Mr. Collens similar information was secured regarding English Harbor, and this became rather an expensive item, as beds and mattresses had to be rented of an Antigua firm at a much higher rate than we had anticipated.

The Commissary Committee busied itself in figuring out the kinds and quantities of provisions necessary for a party of nineteen for a period of approximately ten weeks, and also in ascertaining what eatables could be secured at Barbados and Antigua and at what prices. We decided to depend upon the local markets so far as possible and took only a few canned vegetables and a fifty pound drum of coffee, as Americans and Britons do not agree as to what is good coffee.

In general we found that food was cheaper there than at home, particularly meats and tropical fruits. We opened our eyes and were thankful when we found that pork chops, for instance, cost only fifteen cents per pound at Barbados, when we had been paying forty cents at home and felt that we were

miserable sinners when we indulged in it at all on account of the dire straits to which our allies were being driven, according to Hoover and the other food conservation officials.

So far as we could ascertain, there was no attempt at food restriction in the Lesser Antilles, the fact seeming to be that when they had wheat or other commodities which are in the restricted list at home, they used it without any government control whatever. When for some reason they failed to receive the regular shipment, they did without until their "ship came in." While we were there, there was absolutely no restriction on the use of wheat, meat, or sugar. In regard to the latter we were startled when we were charged eighteen cents per pound for granulated sugar, having supposed that sugar would be relatively cheap in islands where the sugar industry predominated. We ascertained, however, that sugar, although originally produced at Barbados, was all sent to the United States to be refined; hence we had to pay heavy transportation charges both ways. We finally used the unrefined "yellow crystal" sugar, which did quite as well and cost seven and one-half cents per pound.

Butter was about the only ordinary commodity that was notably dearer there than at home. We were charged ninety-five cents for this at Barbados, and it was so unpalatable at that that few of our party could eat it. We solved the problem by not using butter at all, which is not so bad if you are used to it.

Bananas and oranges were very cheap at Barbados, but not at all plentiful at Antigua, where their places were supplied by extraordinarily delicious pineapples, which were abundant and cheap. Guava jelly was much appreciated and devoured in amazing quantities by some of us. Potatoes and yams were supplied at both places at about the price of potatoes at home. Sweet potatoes were cheaper than the others but seemed of poorer quality than ours. There was seldom any shortage of meat in the markets at Barbados and St. Johns, Antigua, but it sometimes happened that the dealers failed to send it out on time at the latter place. Fish was abundant and good at Barbados. The famous flying-fish of that island was greatly liked by most of us, while the fishermen with their fishpots employed by us secured a welcome addition to our food supply.

At Antigua the fishermen were less energetic and the supply furnished us not adequate to our needs.

Turtle meat was occasionally available and cheap. Some of the party seemed to have a prejudice against this excellent meat, however, although they liked it when it first appeared upon our table as "veal." Chicken (or "fowls" in the Anglicised version) were only occasionally to be had and so small that one of them would hardly make a man a meal. Eggs were abundant and considerably cheaper by the dozen than at home. Their diminutive size, however, made them really hardly less expensive than in the United States.

The Committee on Laboratory, with Dr. Job as chairman, had the task of organizing a novel experiment in the way of devising a temporary laboratory for a month's work in each place. All other expeditions from the University had devoted their energies to the collecting of material, together with field notes and observations on living forms in their natural surroundings. It was our purpose to be prepared for regular laboratory work with suitable equipment for research not heretofore carried by similar expeditions. For this purpose not only microscopes, both compound and dissecting, together with ordinary dissecting tools and reagents; but special methods of keeping marine forms alive and under observation, together with equipment for experimental work and special histological operations, had to be thought out.

It was hoped to do a good deal of this sort of work with fishes, echinoderms, etc. of the larger sorts. A live-car was therefore planned that it was thought would be of great use. It was found, however, that most of the fishes were secured by the use of fish-pots which were necessarily placed some distance from our laboratory, and their contents were almost always dead or dying before they could be brought in and put in the live-car. This car was made of wire netting on a strong wooden frame and was divided into three compartments each opening by a door at the top. It cost an unconscionably high price at Barbados and proved too large and cumbersome to transport to Antigua. It must be confessed, therefore, that it was not a brilliant success.

A considerable quantity of glassware for temporary aquaria

was taken along and found very useful. It was practically out of the question to have aquaria with a constant supply of running water without expenditure of more time and labor than we thought worth while. Negro labor was cheap and we came to rely on this to carry the fresh sea-water in buckets for the aquaria when specimens were to be kept alive.

A box of books selected from the zoological library was an indispensable adjunct to our laboratory. Of course a number of particularly desirable volumes were not included, and we were impressed with the fact that a more deliberate study of our wants in this direction would have yielded better results. I suppose this would have been the case, however, even if we had been more careful in our choice of literature.

Taken as a whole these committees did excellent work and made it possible so to divide the labor of preparation as greatly to reduce the important omissions and materially increase the efficiency of our outfit.

Several matters of importance did not seem to fall within the province of either committee, and the director tried to attend to such items. For instance, a medicine chest was prepared under the direction of Dr. C. P. Howard, the contents of which met all demands, which fortunately were few; and Dean Breene of the College of Dentistry furnished us with a very compact and well selected dental kit.

A letter from the Colonial authorities at Barbados suggested that it would be well to send someone in advance of the party to get our quarters ready for occupancy. This very important duty was kindly accepted by Professor Walter K. Fisher of Stanford University, who represented that University and also the California Academy of Science on our expedition. He had been associated with the writer as civilian naturalist on the Hawaiian cruise of the "Albatross" in 1902 and was heartily welcomed by us all. He sailed two weeks in advance of us and was accompanied by my son, Willis Nutting.

But the most perplexing and at times exasperating experience in the preparatory stages of our undertaking was the meeting of the new and complex regulations regarding passports and securing a war-trade license necessary to taking our equipment out of the country. Indeed, it seemed to me that if the Germans

should find it as difficult to get into the United States as we did to get out of it, our country would be safe. In obtaining a passport we came to entertain serious doubts as to whether we really had been born or not, so difficult was it to furnish details of the event that would satisfy the inquisitive Department of State, which demanded the testimony of either a parent or the attending physician. With a man past middle life this is an embarrassing situation. In my case none of the persons who could testify regarding the interesting event of my nativity was living. Although personally present, my own testimony was not admitted, probably on the ground that I was regarded as a prejudiced party. And so the Bureau of Citizenship, Department of State, had to be content with the information that the applicant had good reason to believe that he actually had been born and had grown up under the personal impression, from hearsay evidence, it is true, that he was born at a certain place and date and that the family Bible so stated.

The obtaining of passports, however, was mere child's play in comparison with the attempt to satisfy the War-Trade Board in regard to getting out our equipment. The officials of that board, after expressing a most courteous desire to issue the necessary war-trade license, proceeded to put the whole set of papers in a pigeon-hole and forget all about it. The trouble was that the regulations were devised to meet the necessities of legitimate commercial enterprises and not to provide for the very unusual situation when a State desired to use its own property for its own purpose in a foreign country, and that purpose had no commercial bearing whatever. The various blanks to be filled out would in no wise fit a situation such as this. To give just one item: It was expressly demanded that a special permit be applied for on a separate blank for "each commodity" for which a permit to export was desired. Now as our outfit embraced over a hundred separate commodities, it would have taken several weeks to fill out the separate blanks and Heaven only knows how many months to have them passed by the War-Trade Board! Then the consignor and consignee were the same person, namely, the director of the expedition, and I was required to solemnly swear that both of these individuals were

true and loyal citizens, or words to that effect. In fact it became such a case of involved personality that there was reason to fear for the sanity of the distracted director before the matter was adjusted.

After being assured by the Secretary that the War-Trade Board had consented to the issuance of the license and that it would be forthcoming on the presentation of the "enclosed blanks properly filled out," and after the blanks had been returned filled out according to the best advice I could get, an ominous silence ensued. Week after week passed and we wanted to ship our goods east, but nothing was heard from the War-Trade Board regarding the license. And then Henderson to the rescue! Being a resident of Washington, having written a standard work on diplomacy, and hence being acquainted with the ins and outs of the Circumlocution Office, he proceeded to camp on the trail of that war-trade license, stalked it to its lair in a forgotten pigeon-hole, actually secured it properly signed, sealed, and delivered, and triumphantly mailed it to me just in time to save reason, which was decidedly tottering.

And then all sorts of awful things were told us about the customs regulations at the port of departure. We were not allowed to take with us any printed or written matter whatever, either on our person or in our baggage. Nothing but "absolutely necessary wearing apparel and toilet articles" would be allowed as baggage. Now all of our equipment was to be taken *as baggage*, by a special very generous arrangement with the Quebec Company. This included various notes, lists, scientific papers and books, charts, chemicals, instruments, etc., not associated in any way with the toilet. This "baggage" was all to be taken in the name of the director of the expedition, who began to see visions of an aggregate sentence of many lifetimes in a federal prison on account of infringements of the law too numerous to mention. But I have always found that officials "higher up," where they are allowed some exercise of judgment, are entirely reasonable and courteous when a matter is plainly presented for adjudication; and that they can usually be depended upon to meet the situation, however unusual, with entire sanity and justice. Such indeed was the case with the New

York customs official, who finally smoothed out all our difficulties and allowed us free exit with our varied items of equipment.

Owing to the congestion of traffic and uncertainty of delivery by freight, we were forced to ship our entire equipment, consisting of fifty-odd packages, by express at a considerable expense. Even at that there was much uncertainty about its getting to New York on time, as the government had recently taken over the railroads and the agents seemed unable to guarantee anything. In this connection, I wish to express my admiration for the success with which our effects, including considerable glassware, were packed under the supervision of Mr. Stoner and Dr. Job. There was remarkably little breakage, although the entire equipment was packed and unpacked three times before returning to Iowa City.

At last all was ready and our tickets had been bought and reservations secured by Professor Thomas, our efficient transportation agent. The Barbados-Antigua expedition left Iowa City on the 23d of April, 1918, with the following members enrolled: Professor A. O. Thomas, member of Executive Committee and Geologist; Mr. Dayton Stoner, member of Executive Committee, in charge of collections, and Entomologist; Mr. John B. Henderson, in charge of dredging operations and the collection of Mollusca; Professor Walter K. Fisher, in charge of collection of Echinoderms; Dr. Thesle T. Job, in charge of laboratories; Mr. Maurice Ricker, official photographer; Mrs. C. C. Nutting, matron of the expedition; Mrs. Dayton Stoner, assistant in entomology; Miss Catharine Mullin, in charge of collections of Annulata and allied forms; Miss Gertrude Van Wagenen, in charge of collections of corals, anemones and medusæ; Miss Mildred Sykes, originally in charge of the Alcyonaria, but afterward assisting Mr. Henderson with the Mollusca; Mr. Sydney Greenlaw, captain of the launch; Mrs. Thesle T. Job, assisting in laboratory; Mrs. A. O. Thomas, assisting in geology; Mr. H. J. Wehman, in charge of Protozoa, and artist; Mr. Willis Nutting, in charge of collection of fishes; Mr. Dwight Ensign, in charge of collection of Crustacea; Master Carl Nutting; and Professor C. C. Nutting, director and chairman of the Executive Committee.

Two members, Professor Walter K. Fisher and Mr. Willis Nutting, had gone ahead as advance agents; and three, Mr. Henderson, Miss Sykes, and Captain Greenlaw, were to meet us in New York. And so fourteen of us said goodbye to our friends and the Barbados-Antigua expedition was at last started on its adventure. Not quite fourteen either, as one member as usual had forgotten something which he at the last moment went back to secure and thereby missed the train, afterward joining us at Pittsburgh.

Our transportation agent had arranged for us to spend a day at Pittsburgh, where we devoted practically all our time to a visit to the Carnegie Museum under the guidance of the director, Dr. Holland, who generously gave of his time and vast fund of information to make the day a memorable one for us.

We had allowed two and a half days for New York, and found that we needed all of it to complete our preparations for sailing. It was necessary to have our passports viséed at the British Consulate, which we found besieged by a crowd of frantic travelers. The passports had also to be inspected and passed upon at the customs house, where great confusion had been occasioned on account of the fact that two transports due to sail on Saturday had received sudden orders to depart on the *preceding Thursday*, and no other persons would be attended to until the passengers on these transports had been passed.

Our worst trouble was at the French Consulate, where we were instructed to have our passports viséed in order to go ashore when the vessels called at the islands of Guadeloupe and Martinique. This was the only place where we were treated with pronounced discourtesy, the understrappers refusing to give us their attention long enough to understand what we wanted and also refusing to allow us to see the Consul himself or any other "higher up" official. They calmly insisted that it was absolutely necessary for us to present a copy of our original application for passports, at that time filed away, goodness knows in what pigeon-hole in Washington. This was all the more aggravating from the fact that my son, only a week before, had had his passport viséed without any such demand being made, and at the very same consulate and for the very same trip. Finally we gave it up, after wasting more than

half a day of very valuable time, only to find when we got to the French islands that no passports were demanded, and everyone went ashore as he pleased without any formality whatever!

Then there was more trouble about our export license, which had been left by Dr. Fisher with an official of the Quebec Company and nothing done with it until I accidentally discovered it and had a lot of further formality to go through with the customs officials. These latter were, however, very courteous and did all they could to expedite matters. To cap the climax, our barrel of alcohol, an absolutely indispensable part of our equipment, was not delivered to the Quebec Company according to agreement, and had to be located and its delivery secured the evening before sailing.

Taking it all in all we had more trouble in getting away from the country with our various effects than at any other time during the actual cruise, and were indeed thankful when we found ourselves on board the "Guiana" with our goods accounted for. The verdict was *never again in war time!*

CHAPTER II

OUTWARD BOUND

After the strenuous life of the preceding days it was an immense relief to find ourselves on shipboard with the prospect of a restful voyage of two weeks, involving one of the most delightful cruises imaginable, including visits to many of the beautiful islands of the Lesser Antilles, and with nothing to do but enjoy ourselves.

The "Guiana" is the largest and most modern of the Quebec Company's ships in the West Indian service, and we had been assigned quite comfortable quarters on board. The dingy war gray of the vessel was not particularly inspiring, to be sure; but we had anticipated that and were not greatly depressed thereby. There was no leave-taking, as no one was allowed on the pier except passengers and Customs and Quebec Company officials. Not even bouquets or any other packages or messages could be delivered to prospective passengers after they went aboard the steamer. The great war brooded over everything. No one was travelling for pleasure, and but few women and children were on board. All field-glasses and cameras were placed in charge of the purser, to be delivered after we were out of sight of land.

The afternoon was sunny and the passage down the harbor along the water-front of the world's largest city was one of the most interesting of our experiences. Nearly all of the trans-Atlantic vessels were armed and painted a war gray or else camouflaged. The noble water-front of New York is always imposing, and the Statute of Liberty is one of the most majestic of all human art productions. We saw the steamer "St. Paul," which had overturned at her pier under mysterious circumstances the day before.

After we left the pilot and passed out of the bay, the wind freshened and it became decidedly chilly, although not rough.

During that night, however, the wind increased to a gale. The expected happened, and all but three of our party were undeniably seasick the next morning. The writer is one of those exasperating persons who are not attacked by this absurd malady, and is conscious of his unpopularity while in a seasick crowd. He has found from long experience that it is best to keep away from the afflicted ones, and when circumstances make his presence necessary, to be as meek and unobtrusive as possible. Captain Greenlaw, who has been used to salt water all his life, and Mrs. Thomas were the others who were immune throughout the cruise.

That day was the roughest of the entire voyage, and the decks were awash most of the time. We felt considerable concern for our launch, which was lashed on the after deck, but no harm came to her. A number of carboys of sulphuric acid carried on deck were smashed and threatened a fire, but were promptly thrown overboard and the danger averted.

More of our party made their appearance at lunch and still others at dinner. Captain Spinney told me of an unusual misfortune that had befallen a little boy, son of an American physician, who went with us to Antigua on the "Parima" the summer before. He had suddenly become very cross-eyed and been returned to the States for treatment.

The next day, Monday, April 29th was bright and the gale had died away, leaving a moderate sea; and almost all the members of the expedition appeared on deck most of them over their seasickness and able to enjoy life again and become acquainted with their fellow passengers. One of the latter had been on the ill-fated "Lusitania" when she was sunk, and was taking this voyage to recuperate his health, which had been shattered by the terrible experience. Another most interesting passenger, Dr. J. B. Nies, is an accomplished Assyriologist and very widely travelled, having visited most of the localities of archaeological interest throughout the world. He was going to St. Thomas, where he had bought the famous "Bluebeard's Tower," known to all who have visited that island.

The next day was still fine, and all of us were enjoying life immensely. We had crossed the Gulf Stream, and warm weather and blue seas were to be our portion for the rest of

the cruise. We managed to hook up some sargassum weed, and enjoyed studying its animal population. These constituted the first specimens collected during the voyage and included several bryozoans, plumularian hydroids, pycnogonids, etc.

The remainder of the six days' run to St. Thomas was uneventful, but delightful and thoroughly restful. We became acquainted with our genial skipper, Captain Spinney, who had been in command of the "Parima" when I went south before. He extended many courtesies to our party throughout the trip.

Life at sea in these latitudes is a deliciously lazy one. The weather is usually fine, the air soft and not hot, the water the bluest of blue, and the sky blue for the most part, but girdled around the horizon with the beautiful columnar "tropic" clouds. We watched the countless small schools of flying-fish rising suddenly, skipping along the crests for a hundred yards or so, and then plunging into the water. By night we leaned over the rail and watched the sparkling of the phosphorescence caused by innumerable pelagic organisms. Often there was music in the evening in the gloom of the lightless decks. Miss Mullin's voice usually led, and a very sweet voice it was; while Stoner accompanied with skillful strumming of the mandolin, of which he is master. Quiet groups dozed in the deck-chairs or engaged in low-toned conversation. Then to bed and sound sleep until another perfect day dawned with its round of rest and enjoyment. Eating was the only serious business that had to be attended to, and every man and woman did the menu full justice.

Truly it was a life abandoned to a "dulce far niente" mood, and the time passed most pleasantly until on the morning of Friday, May 3d, the high hills of St. Thomas loomed ahead, and we were reminded that the world was not all blue sea after all. Then there were letters to write and preparations to be made for landing at this, one of the newest of the possessions of Uncle Sam.

It was a first visit to a tropical land for most of the party, and the beautiful town of Charlotte Amalia, with its abundant palms and variously tinted houses rising tier above tier over the harbor front, was one of the most picturesque places we

visited, reminding one very strongly of Italian cities along the coast of the Mediterranean, the architecture being distinctly Moorish.

There was no formality at all about going ashore, and all were eager to go. Henderson, Thomas, and I paid our respects to Rear Admiral Oliver, the Governor of the Virgin Islands; being introduced by Dr. Nies, who later took us in charge and did the honors of host at "Bluebeard's Tower," which he had very completely restored and from the top of which is a very charming view of the town and its surroundings, together with the port and island-studded sea. In the evening we enjoyed a call from Dr. Butler, U. S. N., who was surgeon on the U. S. S. "Albatross" when I was aboard during the Hawaiian cruise of 1902. I was not aware that he was stationed here and we had a most interesting confabulation on old times. He was accompanied by Dr. Haakensen, U. S. N., with whom I had become acquainted the summer before.

From that time on we "made a port" at least once a day, and this is what makes the West Indian cruises of the Quebec Company so ideal, affording as it does its daily quota of novel scenes and strange people. Each island has its individual and peculiar customs which tempt the visitor to linger even longer than the time-tables of the steamers allow. St. Croix, or as many people call it, Santa Cruz, another of the Virgin Islands, was visited the next day. Here we met with the novel and not altogether pleasant port regulation which forced all passengers to get up early in the morning to have their passports examined. These are taken ashore and retained, to be called for by the passengers when they return to the ship, a rather senseless proceeding, it seemed to us, and one not required at any other port at which we touched.

The whole matter of port regulations is beyond the comprehension of the ordinary civilian. Each island has its own procedure, and this bears no evident relation to the regulations of any other island. It would seem to the unilluminated mind that two islands belonging to the same government, namely the United States, and under the jurisdiction of the same Governor, as is the case with St. Thomas and St. Croix, would have the same, or at least similar port regulations. But the powers

that be have decided otherwise, much to the discomfort of United States citizens who wish to visit these ports of the national domain. Charlotte Amalia, the port of St. Thomas, has the harbor and town well lighted at night, while the port of Frederiksted, St. Croix, is plunged in darkness, constituting a grave peril to navigation, especially in thick eather; a condition which caused grave danger when the "Parima" overran the port at St. Kitts on a thick squally night the year before, when I was returning from the Barbados. Of course it may be said that St. Croix has no land-locked harbor, and its port is more open to attack on that account, but I very much doubt if the danger to the town of reasonable port lights is as great as the danger of no lights to vessels trying to make the port at night. Moreover, the towns along the coast are not rendered less liable to attack by this procedure. Any U-boat commander could spot the desired objective during the day with perfect impunity and shell it without any trouble whatever either by day or by night. The British admiralty seems to have at last come to the conclusion that the ports should be lighted. In 1917 they were rigidly darkened, but Governor Best of Antigua informed me that the order had recently been rescinded or greatly modified. Quite a number of our party went ashore at Frederiksted, where we secured automobiles and took a drive over to Christiansted on the opposite side of the island. The roads were excellent and the novelty of bowling along between rows of stately palms and through great sugar estates, with many beautiful vistas of tropical valleys between hills that would be called mountains at home, with a glimpse of the blue sea beyond, was hugely appreciated by the Iowa folk. Christiansted is a quaint old town, greatly reminding one of the Moorish coast villages. In many cases the houses of the wealthier residents are occupied by shops or business offices below, the family living quarters being in the second story. Much rare old furniture, mostly mahogany, is still to be found in such places, and I met a Jewish lady who claims to make big money by searching out such treasures and buying them for a comparatively small sum to sell to connoisseurs in the United States. There are extensive coral reefs on the eastern side of the island that would doubtless be fine collecting ground for littoral and shallow water forms.

Coming back, we utilized the time afforded by a deflated tire in sending one of the boys up a tree for green cocoanuts, the first many of us had sampled. The "milk," or rather water, is cool sweetish, and perfectly safe and healthful to drink. Many a time in past years I have blessed this refreshment when collecting in tropical countries and hot and tired after a long tramp. On my previous trip I had noted a curious illustration of how seemingly trivial things prove a serious annoyance under changed conditions incident to a transfer of territory from one nation to another. In taking over these islands, the United States government stationed marines at this port. These men either did not know, or else often forgot that the Danish rule of the road is to turn to the left instead of to the right, as with us. This was most exasperating to the native autoists, and I remember that our chauffeur was most hearty in his curses at the stupidity of the drivers of the U. S. auto trucks lumbering across the island and doggedly turning to the right in seeming defiance of the custom of centuries.

The island of St. Kitts came next and was the first of the British possessions that we visited. It is exceedingly picturesque with its lofty mountains, vivid green sugar plantations, and groves of palms. Basse Terre is the port and largest town, and has many substantial buildings public and private. Here, as in the other British islands, there is little formality regarding passports and permission to land. The vessel anchors about a half mile from shore and a swarm of row-boats and lighters make a dash for the steamer as soon as the quarantine officers have discharged their duties. At all of these islands these boats in quest of the patronage of passengers fairly mob the steamers, and it is no small job to manage them and bring order out of chaos. The official who admirably accomplishes this at St. Kitts is my friend, Sergeant Major Geen, reputed to be the best police official in the Leeward Islands. He is a fine specimen of the negro at his best; intelligent and soldierly, and utterly fearless. When in his white uniform and helmet and clothed with the authority of his office, he has absolute control over this wild mob of boatmen. Standing at the head of the gangway, he gives his crisp commands in a voice that would do credit to a train caller in a metropolitan station, and his word is obeyed on the

instant and without debate. He and the writer were fellow passengers on the trip from Barbados to St. Kitts in 1917, and I came to thoroughly respect and admire him as a very exceptional man, solid and trustworthy in any emergency. The police officers in all of these islands are invariably colored men, and I would match them in soldierly bearing and military discipline against the best of policemen anywhere. They seldom, if ever, attain a rank higher than Sergeant Major, but that is an office of dignity and importance in the British service.

We visited St. Kitts on Sunday, and all of our party went ashore, some to church and others to stroll around in the Botanical Garden and other places of interest. Professor Thomas, Wehman, and Ensign took the day to make the ascent of Mount Misery, the highest mountain on the island and the first volcano that we had seen, although it is not in eruption save for the emission of sulphur fumes and hot springs. On the way they passed through forests of tree-ferns and many other new and strange trees and tropical plants. At the top they attained a magnificent view, but the look into the crater was somewhat disappointing as nothing was to be seen but steam, which brooded like a fog over the great cup in the mountain's top.

As evening drew on and the hour for our steamer to sail approached, we became anxious about this party, but they made their appearance at eight o'clock, tired and hungry, and greatly pleased with their excursion; but wroth with the man of whom they had hired an auto to take them to the foot of the mountain and return, and charged them an outrageous price therefor.

That evening His Excellency, Governor T. A. V. Best, Acting Governor of the Leeward Islands, came on board to go to Antigua, which is the administrative capital of these islands. It was at this time that I first met him, although destined to become well acquainted and greatly indebted to him for many courtesies and favors both official and personal. He was accompanied by his secretary and aide, Captain Nicholson, another man we were to come greatly to appreciate and admire. In this our first interview, the Governor, with whom I had already corresponded, expressed himself as desirous of aiding our expedition in every way in his power; a promise that was more

than a formal expression, as was amply verified during the stay of our party at Antigua.

The next day was a busy one for some of us, as we arrived off St. John's, the capital of Antigua, about seven in the morning and wanted to do as much as possible in the way of preliminary arrangements for our work on this island, where we planned to spend about five weeks after leaving Barbados. Mr. Collens, who had kindly agreed to act as our advance agent at Antigua, came off in the Government launch and reported on the efficient work already done in his methodical and business-like manner. He told of much that had been accomplished by Professor Fisher and Willis Nutting, who had called there on their way to Barbados, just a week before. Mr. Stoner and I accompanied him in the launch back to St. John's, and when we landed the Governor invited us to lunch at Government House.

Mr. Collens took us to call on various parties with whom he had made preliminary arrangements regarding our quarters at English Harbor, commissary supplies, etc. We called on Colonel Bell, commander of the forces of the Leeward Islands, who agreed to give Mr. Ricker every possible facility for his photographic work at Antigua. A visit to Mr. Griffith, the customs official, made it evident that the regulations would be waived in our case and all our effects entered free of duty. Mr. Forrest, a leading merchant much interested in geology, arranged to provide beds, cots, mattresses, pillows, and mosquito nets for the party at a definite rental; while the firm of Bennet, Bryson and Co. undertook to provide a sloop to convey our luggage and equipment from the steamer to English Harbor. Arrangements were also made with Mr. José Anjo for auto service and with the telephone company for the installation of an instrument at the dockyard.

After an informal, but very enjoyable lunch with Governor Best and Captain Nicholson, Mr. Collens took us in an auto to High Point, where we saw living coral growing close inshore; and went through a very up-to-date sugar factory. We left for our steamer at 4 P. M. with the feeling that our interests were being excellently attended to.

Upon reaching the vessel, I found that Henderson had hired a boat and taken a party for a swim off a sandy beach opposite

our anchorage, and they had acquired a fearful sunburn. Henderson was not able to get rid of a cold caught during the first chilly day at sea. The ship's doctor was outraged at his taking that swim, and scolded him roundly for it. Henderson takes good care of everyone but himself, and the doctor got even with him by giving him more "dope," he said, than he had ever taken before in his life. The doctor was of the old school and had his own method of dealing with seasick folks, which was not to let them do anything they wanted to in the way of eating or drinking, and to keep them in bed as long as they would stand for it. He had a grudge against "Mothersill's Seasick remedy" and woe be to the passenger who took it during that voyage.

Captain Greenlaw had acquired a fine big soursop while ashore and shared it with our party, most of whom pronounced it delicious. It gives a remarkably fine flavor to ice cream or to a drink somewhat resembling lemonade.

We made Guadeloupe early the next morning, the first French island that we visited, and all were glad to go ashore in a really foreign port. No passports were asked for, and we were more than ever disgusted over our exasperating experience at the French Consulate in New York. We landed at Pointe a Pitre and found ourselves in a city as foreign in appearance as could be imagined. The most interesting place is the market with its swarms of negroes talking French patois and all shouting at once. Some of the vendors had little tables in front of them, while others squatted on the ground with their merchandise around them. There was a great display of tropical fruits and vegetables, many of them strange to us, although the familiar oranges, bananas and mangos were in abundance. We found some fine avocados or "alligator pears," of which I am extravagantly fond. The butchers' stalls were anything but inviting and we noticed a mangy dog that promptly cleaned the chopping block with his tongue after each customer was served. We refrained from buying any meat.

It was here that some of us first saw chocolate, coffee, vanilla, and nutmegs in their native state. Here too we first became acquainted with the "swizzle stick" used in mixing the cock-

tail so popular in all of these islands. Shark meat was sold in several of the stalls and seemed highly appreciated by the people.

A fruit resembling red pepper attached to a big kidney bean, except that here the red pepper is yellow, reminded me that I had encountered the same fruit many years ago in Central America under the name of "marañon." In the West Indies it is known as "Cashew." The fruit is pleasant, but has decidedly astringent qualities. The "bean" contains a nut which is roasted and tastes somewhat like almonds.

In the streets adjacent to the markets are many shops, some of them rather pretentious, where all sorts of things are for sale, including French cosmetics and perfumes, which appealed to some of our ladies. We had a good deal of trouble in our efforts to purchase things, both on account of the language and the money. United States or British money is not accepted; so Henderson, with his usual generosity, rushed to a bank and secured a lot of good French coins. We were astonished to find that perfectly good French silver would not "go" here, and neither will the coins of the neighboring French island of Martinique! An enterprising Creole woman in the market did at last change some of our English money, but our patronage was much reduced by the unique insularity of the money question.

The day was rainy and we had to do our sight-seeing between showers. We visited the cathedral and admired the gorgeous interior with its imposing high altar and many candles. Then back to the "Guiana," contented but tired. It is strange how soon the ship becomes home to the traveller and how soon real friendships are formed aboard, more promptly, it seems to me, on these out-of-the-way cruises than on the more imposing trans-Atlantic liners in past times. I was reminded of this that same evening when we put into the port of Roseau, Dominica, where Mr. Sowray, a friend on my previous trip, came twenty miles from his estate to visit an hour with us on board the "Guiana." He had left a wife and son in England and was anxious to learn the opinion of the United States regarding the probable duration of the war. What a curse the thing is, affecting people even in the remotest islands of the sea!

That same evening we had a talk by Professor Holborn, one

of the survivors of the "Lusitania," who gave a most vivid word picture of that great tragedy. He said, among other things, that literally hundreds of lives were lost because of ignorance regarding the proper adjustment of life preservers. When the straps were too long, the unfortunate victims were floated with feet up and heads down.

In the morning we went ashore on Dominica, in my opinion the most beautiful and most interesting of all the Lesser Antilles, at least from the naturalist's standpoint. It reminds one very strongly of some of the Hawaiian group, particularly Oahu. The lofty mountains had their summits concealed by clouds, while the deep gorges and canyons between them still held the mists of the morning, shot through here and there with sunshine, revealing the vivid green of tropical vegetation. Limes and cocoa are the main products; but the owners of the lime estates were greatly perturbed at this time by an embargo which the United States had just placed upon the importation of limes. I understand that a factory for the extraction of lime-juice here has a large contract with the British Government for supplying its army and navy. We were greatly surprised to learn that the chief commercial use for limes is in the manufacture of dyes.

Of course we visited the famous Botanical Gardens, the best seen during the cruise, and a more beautiful display of tropical plant life could hardly be imagined. Palms of various species are the most prominent features, and bamboos of wonderful size and variety are exceeding attractive. Most gorgeous of all is the flamboyant tree, with its huge masses of scarlet white-centered blossoms. Another tree, called the "pudding stick tree," was covered with bright yellow bloom. Tamarind trees with their long pods, like those of the catalpa at home, and fine fern-like leaves, made great masses of deep shade, while the "sausage tree" and the "canon-ball trees" attract the attention of the curious.

There is a little public museum here, the only one that I saw in any of the islands, where many things of interest to the zoologist are displayed. A huge beetle is exhibited, with enormous pincer-like horns that are used in a unique manner. They are curved toward each other and serrate on the inner or con-

cave side. The insect grasps a small branch with these caliper-like horns and then propels itself round and round with its wings whirling like a pin-wheel, cutting a neat girdle around the branch, or severing it completely.

Mr. Henderson's cold was much worse on this day and the doctor declared that he was threatened with congestion of the lungs and ordered him to keep to his berth, a real trial when we were having so many interesting experiences ashore.

In the afternoon we passed the island of Martinique, and the vast bulk of Mt. Pelée loomed up impressively as we steamed along the coast, its top enshrouded in sombre clouds. Of course our thoughts were occupied with the awful tragedy of 1902, when forty thousand lives were here snuffed out by the huge volume of incandescent gas that belched forth from the crater of Pelée and rolled down over the doomed city of St. Pierre near its base. This is doubtless the only known case in the world's history where such a large number of human lives were lost, probably in the space of a minute or two. The best account that I have seen of this catastrophe was written by the Very Reverend G. Parel, Vicar General and Administrator of the Diocese of Martinique, a translation of which appears in the *Century Magazine* of August 1902, page 610. I quote the following from his exceedingly graphic narrative:

"Suddenly, at ten minutes before eight o'clock..... a tremendous detonation shook the whole colony, and an enormous mass was seen to mount with vertiginous rapidity straight into the air from the mouth of the crater. The black spirals of the column, shot through with electric discharges, unfolded, rolled off into space, and, driven by an invisible power, went afar, to throw off the incandescent matter contained in their flanks. A spout-like column of flame meanwhile had abruptly disengaged itself from the great masses, and had burst over St. Pierre like a hurricane, enveloping the city, roadstead, suburbs, in one dreadful net. 'Everything went down and everything caught fire.' Deep night spread over the land, but it was immediately illuminated by the flames of this inferno. From the grass of the savannas to the produce in the fields, from the houses and edifices of the city to the ships in the roadstead, everywhere, on

sea and land alike, there is but one great conflagration consuming thirty thousand lives.

"Wreckage and the up-turned keels of boats strew the roadstead, and this is all that is left of the thirty or forty ships anchored here the day previous."

Among these ships was the "Roraima" of the Quebec Company. I was told by the engineer of the "Parima," since dead, that the chief officer was one of the few survivors. As the crew rushed for the shelter of the deck cabin, on seeing the approach of the flaming mass, this officer stumbled and fell. His body was covered by those of twenty-odd men, every one of whom was killed by the blast, and the protection afforded by these his comrades' bodies saved the officer's life.

We were thinking of these events as our vessel steamed past Mt. Pelée on that bright May afternoon and saw that vast scar made on the mountain's flank by the flow of mud and hot water from the crater.

Captain Spinney very kindly steamed in close as we approached the ruined city of St. Pierre, and gave us an exceedingly fine view of the ruins, affording doubtless a better and more realistic impression of the city as a whole than we could have obtained had we actually gone ashore. The whole effect is remarkably similar to a general view of Pompeii, a city much smaller, by the way, than St. Pierre. I noticed that a good many new houses had been erected in the vicinity since I passed by before, and they say that a new city has arisen which in time will rival its ill-starred predecessor.

A short distance beyond St. Pierre a big school of porpoises gave us an exhibition of fancy swimming, hurdling and diving as they followed the ship and played alongside for half an hour or so. One never tires of watching their aquatic acrobatics. Ricker secured a movie of them, of which we hope much.

That evening at dinner the Iowa crowd almost caused a panic on board the "Guiana" in an attempt to show its appreciation of the courtesy of Captain Spinney in steaming in close to give us a better view of St. Pierre. Of course University people know of no better way of showing appreciation than by giving the "yell." So when we assembled for dinner, we waited until the Captain, who usually came down somewhat late, entered and

took his place at the head of the table. Then we rose in our places and Dr. Job proposed "nine rahs for the Captain," and the air fairly trembled with *Rah-rah-rah, Rah-rah-rah, Rah-rah-rah, Captain, Captain, Captain!* The other passengers were simply paralyzed and showed much agitation. Such things are simply *not done* in British steamers, don't you know! The Captain was not much less astonished than the others, and exclaimed, "What th— What's the matter now!" It was explained that this is the Iowa method of conferring the degree of D. Ph., and he accepted in good grace when he understood that he had really received a high scholastic honor. The Captain, a royal good fellow, extended many rather unusual courtesies to our party. We shall remember him with gratitude.

I have been given to understand that the college yell is a thing unknown in England. If this is so, the mother country has something to learn concerning the utility of effective psychological stimuli to carry a mass of men "over the goal," or "over the top." I have no doubt it has been effectively introduced by this time in France, and may in part account for the fear that is reported to be instilled into the Boche mind when our boys charge.

And all this time poor Henderson was shut up in his stateroom and ordered to keep in his bunk by the heartless doctor! I slipped down when we were passing St. Pierre and found him kneeling on the settee and eagerly peering through the port-hole. Some men simply can't be kept down!

We anchored in the harbor at Fort de France; but only to take passengers and discharge and receive mail; no one going ashore unless he meant to stay there. I regretted this, as I had found the town most interesting on my previous trip. The houses are remarkable for their weird coloring, often in broad bands or zigzags of gaudy hues, such as bright red and purple in the most inharmonious contrast; the more bizarre, it seemed, the better. The market was much like that at Guadeloupe, with the same profusion of chattering negroes, strange vegetables and fruits. There is a really beautiful statue of the Empress Josephine in one of the parks, and a library of oriental extravagance in exterior ornamentation, but a paucity of books within.

We were getting ready for the end of our cruise on the mor-

row. Dr. Job, Mr. Stoner, and Professor Thomas were assigned the duty of seeing our equipment, baggage and selves transferred to Pelican Island directly from the steamer. Their lists were ready for inspection and for checking off our property when it was trans-shipped. Letters were written home, to be dispatched in the first south-bound mail.

The trip had been delightful, and we all agreed that a pleasanter cruise could hardly be imagined, resolving to recommend it most enthusiastically to our friends when the blight of the horrible world's war should be removed and civilization returned to its norm. We felt also that the many favors and courtesies that we had received from the Quebec Company and its officers required recognition wherever opportunity offered. To Captain Spinney of the "Guiana" we were particularly grateful. He had gone out of his way to make this trip not only comfortable but enjoyable, so far as the press of his duties permitted.

Our days of laziness and rest, of pleasure-seeking and ordinary sightseeing, were over, and our thoughts turned to the serious duties that should occupy our attentions for the next ten weeks at least. Our only real anxiety was concerning the condition of Henderson, who had developed some serious symptoms, according to the ship's surgeon, and had been ordered to the hospital when we disembarked.

We were all up early in the morning of May 9th, and found the low hills of Barbados, the *Ultima Thule* of our cruise, in sight. Soon we could make out the trees and buildings of Pelican Island, which was to be our home for the next five weeks and looked very attractive in the morning light.

The first man to greet us after dropping anchor in Carlisle Bay in front of Bridgetown, was Mr. Arthur Gill, the admiralty official who had first called my attention to Pelican Island as a suitable place for our quarters, and who was detailed to inspect passports on our vessel. He greeted us most cordially, and announced his readiness to discharge his official duties with as little delay as possible. And so, from the very first, we found ourselves among friends, and met with nothing but extreme courtesy and helpfulness on the part of every colonial official with whom we dealt during our stay in Barbados. They were

not only willing, but *knew how* to facilitate our enterprise in every possible way. They seemed to be impressed with the idea that a scientific expedition such as ours should be encouraged and regarded as beneficial to the places visited.

A customs officer also came aboard, introducing himself as being instructed to pass all our effects without delay and allow them to be trans-shipped to a lighter and sent to Pelican Island direct, without being taken to the customs house ashore; a very considerable concession, generously granted by the Colonial Government.

Everything went like clock-work. Fisher came aboard and reported that all was ready for us at Pelican Island. Our equipment and baggage was promptly taken from the hold and staterooms to the deck and checked off by Stoner, Thomas, and Job as it was transferred to the lighter alongside. These men went aboard the lighter and accompanied our goods and chattels, while the rest of us said goodbye to the "Guiana" and were transferred to Pelican Island in row-boats. "And thus endeth the voyage."

CHAPTER III

PELICAN ISLAND

My son, Willis, met us at the landing, very imposing and business-like in his white suit and helmet, having been detailed by Fisher to receive us and attend to the landing of our effects. Mr. James Sanderson, Clerk of the Board of Health, and immediately in charge of the island, was also there and remained in the hot sun at the landing until he personally saw to it that we were safely housed and our property checked off and accounted for according to our lists. During our entire stay this gentleman charged himself with our comfort and made certain that everything went smoothly in our domestic economy. On this first day he had secured the services of a Corporal of Police to see to it that we were not interfered with in any way and to make himself generally useful.

We were delighted with our quarters, and could not have devised more convenient and adequate accommodations for our expedition had we been given *carte blanche*. The island is the only one off the coast of Barbados, and is situated directly opposite the suburbs of Bridgetown, from which it is separated by a channel about a quarter of a mile wide. It is encircled by a sea-wall of masonry of very substantial construction, as there is often a considerable surf—both on the seaward side and in the channel. There are two small docks or landings with steps leading down to the water. One of these was used by passengers to and from the mainland, and the other faced a little cove where boats from the sea could come alongside.

During our stay, a boat and boatman were constantly at our command to ferry us to and from Bridgetown. A bell was placed on the dock first mentioned, and was used to summon the ferryman whenever his services were needed. This boat was a heavy one, propelled by “poling” it along with an oar. The landing required considerable skill, as the waves careered

through the channel with great force and speed. We often got more or less of a sousing here, but admired the way in which these occasions were reduced to a minimum by "Charon," as we called him.

Each member of the party was assigned to his or her quarters immediately upon landing. The married people and single ladies were housed in comfortable rooms in a building 110 feet long and amply adequate for the purpose, containing also a dining room, sitting room, store room, and kitchen; with an inner hall running the whole length of the building and a piazza in front facing the mainland. There were also toilet rooms and shower baths. The furniture was simple but adequate. There were no mosquito nettings, nor were they needed. After dinner the members of the party usually met on the piazza or occupied seats facing it. Here we discussed our plans, or indulged in singing, accompanied by Stoner with his mandolin.

The unmarried men were accommodated in another building, 150 by 20 feet, near the inner sea-wall, where they had comfortable cots with mattresses and pillows, but not separate rooms. There was a veranda along the entire length of this building on both sides. Some of the men moved their cots out on this veranda, and many of them took an early morning dip from the sea-wall when the tide served. Near this building was a small cabin-like house where Ricker fitted up his photographic studio and dark-room and did excellent work. Ice for his purpose was available, and this and other buildings were supplied with pure fresh water piped over from the general water system of the main island. This water, by the way, was a God-send, being perfectly pure, having its source in underground streams, furnishing excellent cool water in abundance.

Along the streets of the city of Bridgetown and the country roads throughout the island, these pipes are frequently supplied with faucets from which the people take freely of the best of water and use it without apparent limit. I know of no better system anywhere, and it doubtless accounts in a large measure for the remarkable good health of the Barbadians, and incidentally of our party, during our stay.

The buildings just described are separated from the rest of Pelican Island by a high stone wall with a gateway to the

north; and on the other side of this wall is the building which we occupied as a laboratory. It is a large wooden structure, 80 by 30 feet, and like the men's quarters has an elevated porch running the full length of each side. It is near the landing at the north and convenient to the water on both sides. There are numerous windows with heavy wooden shutters conveniently spaced along the side walls; and two doors, one on either side.

There were a number of small but solid tables, one for each worker, opposite windows. Our alcohol tanks formed convenient seats for all. Other tables along the center of the room were used for glassware, reagents, etc.; while two cupboards with doors contained stationery and some general laboratory supplies. In the north end of this main room Dr. Job installed his aquaria, surmounted at the top by a large barrel, into which water was supplied by Eustace, our boy of all work, who dipped the water from along the sea wall a few paces away. From this barrel, rubber tubing led to the various glass vessels constituting the aquaria, which were on a series of step-like shelves made from some of the boxes which had been used as containers for our equipment. We met with a great deal of difficulty in maintaining just the right flow for these vessels, but succeeded in keeping a good many specimens alive for a reasonable time or at least until we were ready to kill them for future use.

The supply of fibre buckets and tubs which we had brought along was immensely useful, indeed indispensable. They were light, durable, and never came to pieces or leaked. They were uninjured during the season's work, and many of them were returned for future use at the University.

The north end of the building was separated from the main laboratory by a partition. Here was installed our "library," and also a place devoted to Ricker, where he photographed living specimens brought in by the collectors.

A number of shower-baths were contained in separate buildings near the laboratory, and these were exceedingly useful in killing and cleaning corals, many fine specimens of which were collected from the reefs quite near Pelican Island. At the extreme north is a sand-beach, which was used as a bathing place, principally by the ladies of the party, and was practically devoid of the black sea-urchins, or "sea-egg;" which is

a pitiless enemy to bathers, with its exceedingly sharp spines capable of inflicting dangerous wounds, or at least very painful ones.

There were a number of other buildings on the island, but these were not occupied by us and were closed during our stay. Taking it all in all, we were delighted with the quarters thus supplied by the generosity of the Colonial Government, and hardly saw how they could have been improved for our purpose. It was considerably cooler there than on the main island of Barbados, and there was a practical absence of mosquitoes, although these were quite troublesome on the mainland. Best of all, we were secluded and could "gang our ain gait" unimpeded by the swarming population of blacks just opposite.

There was no turf on the island, and the ground was sandy everywhere, but there were a number of trees, including palms and many *Cordia*, with brilliant scarlet blossoms and broad leaves. The paths were bordered by rows of "spider lilies," with bayonet-like leaves and strange white flowers having exceedingly slender petals.

The view from the room occupied by Mrs. Nutting and myself was exceedingly beautiful, overlooking the blue expanse of Carlisle Bay, with its ever-changing array of ships from all over the world: for this is one of the most frequented ports in the West Indies, an oceanic cross-roads, used as a port of call for vessels plying between North and South America, as well as between Europe and the east coast of South America. The prevailing winds being from the north and east, this roadstead is well protected nearly all the time.

We were all fairly comfortably settled by lunch time. The cooks had spread themselves on this their first meal. There was flying-fish, the most characteristic of the Barbadian foods, and it was delicious. Yams and rice and carrots and squash were served, as well as oranges and bananas, with a cocoanut pudding by way of dessert. Such profusion was gratifying to the palate; but was altogether too elaborate to suit our needs and purses, and we saw at once that this scale of living would have to be modified.

We had anticipated that the servant problem would be a perplexing one, and it was placed in the hands of Mrs. Nutting,

matron of the party, and the three other married women. Mr. Saunderson undertook the task of arranging for the servants, deciding on the proper wage and acting as paymaster.

The housekeeper was the woman who had previously served the board of health in the same capacity. She was capable and a good business woman, possibly too good. She had her own servant and dealt with her as she pleased; and we often suspected that this involved corporal punishment, if the outcries from the kitchen were correctly interpreted. Then there was a maid to wait on the table, a washerwoman, a boy to help in the laboratory during the day, and ostensibly act as watchman at night. His duties seemed to consist largely in keeping a lantern lighted at night to frighten the thieves who were supposed to inhabit the opposite shore. He was, however, quite willing and faithful according to his lights. The boatman who ran the ferry to the mainland had an assistant who was necessary at times when the surf was running high, and who really did most of the work.

We were thus supposed to have seven servants in our employ, but soon found that the custom of the country was to "ring in" as many additional ones as possible under various pretexts, and there were usually ten or a dozen around the kitchen at meal times. It thus came about that when the time came to pay the first ten days' bill we were staggered at the amount of provisions that had been consumed. For instance, we were confronted with a bill for seventy-five pounds of granulated sugar at eighteen cents per pound; and other items in proportion, although at relatively less cost.

It became evident that our northern ideas did not jibe with those of the natives, who have been for generations in the habit of working a sort of customary graft on their employers whenever possible. It was hard to blame them over much, as their wages were pitifully small, according to our standards; and yet we did want to know how many people we were supposed to be feeding and thus be able to estimate the necessary supplies and bring the cost of living down to a reasonable figure. Mr. Sanderson, however, took a hand in the matter, and being accustomed to such dealings, promptly ordered the supernumeraries off of the island; and things worked more smoothly.

In general it may be said that we lived simply, but had an abundance of wholesome food at a reasonable price; while the service, when we consider that our strange and unusual ways must have been a disturbing factor, was reasonably satisfactory. Our hours for meals, for example, were unheard of in that part of the world, being 7:30 for breakfast, 12:30 for lunch, and 6:30 for dinner; while the usual hours at Barbados were: coffee or tea in the morning, a 10 o'clock breakfast, 2 o'clock lunch, tea at 4:30, and supper or dinner at 7:30. It was hard to convince the servants that meals were expected on time, as they were evidently used to serving them whenever they happened to be ready.

In the afternoon I went over to Bridgetown to cable President Jessup of our safe arrival. It is hard to understand, by the way, why it costs fifty cents a word to cable from St. Thomas and only thirty-five cents from Bridgetown, nearly twice the distance to New York.

I also called at the Colonial Bank, to which I presented letters of credit from the New York branch. Our business affairs were very satisfactorily arranged through this establishment, although I could draw no money without signing a statement to the effect that it was not to be used in any way that would afford aid to the enemies of Great Britain. The checkbook given me was twice the size of ours and too large to carry conveniently in the pocket.

The business of getting settled is always tiresome, and we were all glad to take to our beds that first night on Pelican Island.

The next day was devoted to getting acquainted with our surroundings from the point of view of the zoologist. Professor Fisher superintended this work. As it was low tide in the morning, attention was focussed on the tide-flats on both sides of our laboratory, where it was at once apparent that abundant material awaited us. The stretch of bottom uncovered at low tide was composed of loose coral rocks resting on a sandy substratum. Practically every one of these stones would, upon being overturned, disclose several forms of animal life. Most abundant and conspicuous were large serpent-stars, *Ophiocoma*, which would wriggle away with a celerity that was astonishing.

These were the most common ophiurians, although several species were more or less abundant. I have often wondered why these, the most actively moving of echinoderms, have no eyespots or organs of vision; while the star-fish, much less highly specialized for locomotion, have quite evident pigmented eyespots at the ends of the rays, and even the sea-urchins often have what are supposed to be localized organs of vision. The statement is quite generally made in the classroom that active movement is accompanied by the development of sensory organs, and that there is on the whole a coördination between rapid locomotion and perfection of sense-organs, particularly organs of sight. There is no doubt that this rule holds in a great majority of cases; but the serpent-stars offer an exception not easily explained.

One must be careful in overturning these stones or he will make an undesirable acquaintance with the "sea scorpion," a large annelid, sometimes as much as a foot long, whose parapodia are armed with myriads of poisonous bristles which sting the hand, reminding one of the innumerable fine spines of the prickly pear.

The white sea-urchin or "sea-egg" was found in the deeper portion of the shallows between Pelican Island and Barbados. This is a favorite article of diet with the Barbadians, and is here a staple market comestible during the season. It is protected by a closed season, and we were particularly requested to study its reproduction and habits in order to suggest appropriate measures to increase the supply which seems to be diminishing.

The small, almost black, *Echinometra* are also common, and quantities could be secured near the laboratory. A species of *Chiton* clung to the rocks of the sea-wall, but had to be quickly and skilfully pried loose or they stuck so fast that even a knife would not remove them. They seemed at times to excavate a depression in the rocks in which they fit perfectly and from which they can not be taken.

There were also small sea-cucumbers, worms, gastropods, and a small nudibranch or "sea hare." Beautiful anemones with a spread of eight or ten inches were attached to some rocks, and these often harbored commensal crabs, which lived near their bases and were often captured and devoured when they incau-

tiously touched the very numerous tentacles. Crabs of various kinds were everywhere, scuttling along the sea wall into which they vanished with a flash when approached; it required quick work to collect them. Land crabs and "soldier crabs," or hermits, scurried over the sand, and the surface of the island was riddled by their burrows.

Corals of several species were abundant, often quite close to the shore. *Isopora palmata*, *Orbicella annularis*, and *Porites* were the most common.

The morning's work satisfied us that here was laboratory material in plenty, and of course we had as yet but made a superficial survey of the immediate vicinity. Meanwhile I went to Bridgetown and saw Henderson quite comfortably situated in a private hospital owned by Dr. Bannister. Henderson was cheerful and optimistic as usual, and promised to rejoin us in a day or two. I called also on our Consul, Mr. Livingston. Since my visit the preceding summer this charming family had been heavily bereaved by the loss of their son, who had been shot in a training camp in the United States. He had immediately volunteered when war was declared, taking the first vessel home. Mrs. Livingston had been seriously stricken, but was bravely facing her grief.

I called also on Colonial Secretary Fell, who had done much to secure Pelican Island for our party. He was very cordial in his assurances of willingness to help in every possible way. A short time after this he became Acting Governor, the present incumbent, Governor Probyn, being about to leave for his new post at Jamaica.

I was particularly anxious to secure permission for Mr. Ricker to photograph the innumerable scenes of interest on Barbados; especially the street life in Bridgetown, with its swarming population. The Colonial Secretary assured me that every facility would be given for this work, a promise amply lived up to. Not only was Ricker given *carte blanche* to take pictures to his heart's content; but often, on special ceremonial occasions, he was placed in the best position for his work and officially aided by the police. We thus secured motion pictures of the Governor's departure from Barbados, the procession and other events on the King's birthday, street scenes in Bridgetown, and

anything else that Ricker regarded as good picture material. The only restrictions were regarding shipping in the harbor and gun emplacements. Not only Ricker, but other members of the party having cameras, were free to use them *ad libitum* during our stay.

We were cautioned by Mr. Sanderson to be careful about using lights that could be seen from the sea, a caution that we were very willing to heed, although on one occasion the authorities notified me that a light on Pelican Island had been reported as visible from off the coast.

After lunch Albert Ashby, the diver that I had employed the summer before, came to see me and I engaged him to serve as a diver and boatman for a month. As will be seen, he remained in our services not only while we were at Barbados, but also accompanied us to Antigua and stayed during nearly all of our work there.

We also made arrangements to secure the services of a fisherman named Burke, recommended by Mr. Gill, and his boat, two boatmen, and four fish-pots, for four weeks. By this means our larder was largely supplied with fish, and we secured many specimens for our collections.

I went out with Burke in a small boat, taking Albert along, to make a preliminary survey of the nearest reefs. There were acres of branched *Porites* in two or three fathoms, and many clavate colonies of *Orbicella*, this form of colony being different from those I had seen in the Bahamas, where they were usually rounded heads. *Isopora palmata* was also common. Burke was evidently pleased with the work of Albert, whom he declared was "*a likely boy and some diver.*"

In the afternoon we received calls from Colonial Secretary Fell and Sir Gilbert Carter, also invitations to the party to attend an "at home" at Government House, where His Excellency Governor Probyn and Lady Probyn were to receive us. This was the beginning of a series of invitations that poured in during our entire stay and gave us opportunity to become acquainted with the justly famed hospitality of Barbados.

In the evening a reporter for the "Standard" called for an interview. He was an intelligent colored man, and I was much

interested in seeing the kind of "story" he would produce. I am glad to testify that the article that appeared in a couple of days would have done credit to a reporter for a metropolitan daily, and contained fewer errors than are usually detected in interviews published at home. The "Standard" is a daily paper published at Bridgetown, and contains the "telegrams," embracing important war news censored at Jamaica. It also deals largely with the doings of the Colonial Legislature, and prints the rather prolix speeches of its members *in extenso*. While we were there one man seemed to have the floor most of the time, opposing a movement in favor of an income tax.

Our first working day at Pelican Island seemed to open up many lines of activity and enjoyment, and we felt that our stay on the island would be anything but a period of stagnation. In the evening we got our bearings by the north star and the southern cross, the latter a much over-advertised constellation, in our opinion.

The past two days had been devoted to getting settled and making a preliminary survey of the biological surroundings. From this time on the work was divided into definite assignments under the following heads:

1st. Shallow water and low-tide collecting. A number of the party, varying from three to eight or ten, engaged in this work practically every day, the assignments rotating between the members of the expedition. To this group was assigned the main work of collecting laboratory supplies, both for the present use and for the University for many years to come. In general, those persons who collected such material were expected to see it put away in proper shape, working under the direction of Mr. Stoner.

2d. Row-boat parties, with Ashby the diver and boatmen furnished by Mr. Burke. These worked the nearer reefs and adjacent waters down to a depth of about ten fathoms. A water-glass was taken along, by the aid of which specimens could be seen and pointed out to Albert, who immediately went down to bring them up. This work was highly interesting and successful; resulting in securing numerous fine specimens, particularly of coral, most of them being brought up in the best of conditions. Albert soon came to know the sort of things that

we particularly wanted and became an excellent collector. Later he would go out himself with a couple of boatmen and bring back whatever he was sent after, as well as other specimens which he thought we would want. Sometimes these row-boat squads would take along a small dredge worked with a sounding machine and using piano wire. In this way, depths down to about thirty fathoms were explored. At other times the boat went to places several miles away along the coast to the north or south, and the members of the party would engage in shallow water or beach collecting; or deeper work by the diver, sometimes extending the scope by the use of the boat dredge just described.

3d. Dredging with the launch down to about 150 fathoms. Henderson and I usually took charge on alternate days, being accompanied by two or three other members of the expedition. There were several who were so persistently seasick owing to the constant pitching of the boat when dredging, that they were finally excused from this duty and assigned to other work. It thus came about that the dredging was done mainly by Greenlaw, who always went out and managed the launch with consummate skill, Henderson, Thomas, Miss Sykes (who developed into an excellent hand), Wehman, and myself. Willis Nutting persisted in spite of seasickness, which he almost entirely conquered in time.

These dredging parties frequently got a soaking, either by the spray shipped in the choppy sea, or by the daily rain-squalls which were often quite violent, although soon over. These wettings did us no noticeable harm, however. The work was often quite tiresome, particularly the sifting of the sand brought up by the dredge, but was always interesting; as novelties were disclosed with almost every successful haul.

Sometimes the work was somewhat dangerous, especially when the dredge "hung up" on the bottom when the sea was high and currents strong. On one memorable occasion we had an anxious half hour. The dredge hung badly, and a sudden heave of the boat broke the line attached to the post on the fore deck, thus bringing the strain directly on the davit. Several times an attempt to lash a rope to the dredging wire resulted in the line cutting the rope instantly. The sea was quite high and choppy,

and things looked serious. Greenlaw, however, was equal to the occasion, and finally managed to get a hitch on the post with the steel plow-rope used in dredging, thus bringing the pitch of the boat to bear directly on the dredge, breaking it loose, when it was easily brought up. For some reason the dredge had not tripped.

On another occasion the bicycle chain engaging the drum suddenly snapped, and we had to haul in some 200 fathoms of wire rope by hand, a hard grinding job in a pitching boat, mostly accomplished by the powerful muscles of Greenlaw.

We dredged at just one hundred stations off the western and southern coasts of Barbados. The eastern and northern coasts were impossible dredging grounds for us, on account of the prevailing strong trade-winds and heavy seas, much too heavy for successful work in a 27-foot launch. Besides, these shores offered no harbor whatever, being without indentation or off-shore islands of any kind. In such waters any engine trouble would be fatal, and we dared not risk it.

4th. Land parties. These almost exclusively consisted of Henderson, who was after land mollusks and was sometimes accompanied by Miss Sykes; Mr. and Mrs. Stoner, entomologists; and Professor Thomas, the geologist of the expedition. All of these did good work and secured large series of specimens, some of which will be discussed further on.

In this connection mention should be made of the work of our photographer, Mr. Ricker, who was more or less amphibious and accompanied any party whose work needed pictorial representation. He also often went ashore by himself and wandered about Bridgetown and other parts of Barbados at his own sweet will. As a result, we have not only a very complete series of negatives representing the work of the expedition, and also the life of the Barbadians, both urban and rural; but, in addition, a very large assortment of scenic views of that remote and little known island. It is possibly true that nowhere else has so limited an area been more profusely represented by photography. In addition to the "still pictures," a number of quite interesting "movies" were taken, illustrating not only occasions of unusual public interest, but also depicting the street life of Bridge-

town with its countless swarms of negroes in their characteristic activities.

5. Laboratory work. Dr. Job had immediate charge of this and encouraged the constant use of the facilities at his command. Studies of the embryology of the white sea-urchin, *Hipponoë* were carried on, and in general the living marine forms were investigated so far as time would allow. While the continuity of the laboratory work was seriously interfered with by other activities just described, as well as by the almost constant inflow of specimens a good deal of interesting work was accomplished in spite of these drawbacks.

One of the adjuncts of the laboratory was the "live car" planned by Dr. Job. This was made of wire netting stretched over a wooden frame and divided internally into three compartments. It was attached at one end to one of the bath houses and at the other to the landing dock near the north end of Pelican Island. As noted before the fish were nearly all dead before they could be transported from the fishpots to this car, which was used in keeping a supply of sea-urchins alive for laboratory work.

6th. Hauling the fishpots. Four of these were constantly in use during our stay and were hauled about once in three days. They were anchored out near the reefs and secured a good catch of reef fishes, many of them excellent for food and nearly all brilliantly colored. Hardly any other experience during the cruise was more interesting than contemplating the extraordinary vividness of the contents of the fishpot. No flower bed nor collection of tropical butterflies could surpass the bright color of these fishes, and we all immensely enjoyed surveying the contents as they were brought in. Of course these colors faded very soon after death, and nothing in the preserved specimens indicates their real appearance in life. We were aided greatly in the identification of these specimens by the very beautiful plates in Dr. Evermann's admirable work on the "Fishes of Porto Rico," published by the United States Bureau of Fisheries.

All of these activities kept us abundantly occupied. The various parties usually returned by lunch time, when the welcome sound of the dinner horn of *Strombus* shell, called us with

excellent appetites to the table. After lunch we occupied ourselves in examining and caring for the catch of the morning, including the hasty identification of specimens. Ordinarily, we did not attempt to identify species, but located them in the general zoological groups to which they belonged. Then the notes had to be written up and proper record made of the day's doings.

When a dredging party or boat employing a diver returned, the material was generally brought first to a table where the director made a hasty preliminary examination and rough notes of the assemblage of forms were secured. These were then divided into the larger zoological groups and at once taken to the work tables of the specialists to whom these groups had been assigned. Here they were divided into smaller groups and a hasty attempt at identification was made, color notes taken, and the specimens put into permanent preservatives or started on the process of killing, hardening, etc., as a preliminary to permanent preservation. In some cases they were handed over alive to Wehman to be sketched in their natural colors or to Ricker to be photographed before killing. Occasionally they were photographed by the motion picture camera to show their activities and for future analysis of their movements. Laboratory specimens were handed over to Dr. Job for his aquaria or for special preparation for histological examination.

When any of the workers on special groups found features of unusual interest or species apparently new, they were reported to the director for record. They also reported the names of species which they were able to identify offhand. Each member of the party kept a separate record of his or her special work, such as color notes, observations on living forms, etc. Of course all of the dredged material was dead before it reached the laboratory and only the shallow water and low-tide collections were available for life studies.

By the time these matters were attended to we were about ready to call it a day's work. The evenings were usually spent in resting. Many of us got into the habit of gathering in front of the quarters occupied by the married folks and ladies and talking about our work or previous experiences, or in singing

familiar songs. Some played cards on the diningroom table, and others read whatever light literature was at hand.

Henderson rejoined us on Sunday, May 12th, and reported himself quite well. He is an excellent *raconteur*, and added much to the interest of these evening gatherings. On Sundays we rested from our labors, and some of us attended church. Others indulged in long walks on the island.

A few of the hopelessly energetic ones worked in the evenings. Wehman could not refrain from completing some fine color sketch of a particularly interesting fish or living mollusk. Thomas was unable to tear himself away from his geological specimens. Ricker often worked late in his improvised photographic studio; and Stoner sometimes took evenings to care for the entomological specimens secured during the day.

The moonlight evenings were simply superb. It seems to me that I never saw such bright light from our satellite as we enjoyed at Pelican Island. It may have been partly on account of the white sand which covered the ground; or perhaps the moonlight is really brighter in the tropics than at home. At any rate these nights will long be remembered by many of us. Of course, as was to be expected, a limited moiety of our party became obviously moon-struck and were wont to wonder off by themselves where the addition of another person would have "made a crowd." The ravages of this disease were, however, restricted within the narrowest possible limits and did not interfere seriously with the sociability enjoyed by the others. There was but one real drawback to our happiness here, and that was *fleas*. They evidently enjoyed us, however, and seemed greatly to prefer white to black foraging ground.

The weather was usually fine, the only exception being the short, but often violent, rain-squalls which came with little warning and stopped as suddenly as they had begun.

The natives from the main island often appeared with things of all sorts to sell. Their poverty was so evident and need so great that we were often tempted, and some of us, notably Henderson, became very popular. Some good specimens were secured in this way, however, among which were a number of fine land-crabs, devilfish, and land mollusks.

The boys had great sport with the small lizards that were

abundant, which they "trained" to strike attitudes and be photographed. We found that these chamelions could be "mesmerized" by stroking them gently. In this way they were apparently transfixed in various attitudes. One Sunday morning we were much entertained by a row of these reptiles that were thus posed and rendered rigid with their heads stuck up in the air, where they remained until they were all photographed in most laughable postures.

On one or two occasions we had dancing in the big laboratory room under the electric light furnished by the launch and rigged up by Greenlaw. The servants were greatly interested in these northern dances, particularly when Ricker was inspired to give a realistic reproduction of the Sun-Dance of Arizona Indians which he had witnessed and in which he used the laboratory hatchet in lieu of the tomahawk, accompanied by the weird howls and bodily contortions. Henderson and Miss Sykes distinguished themselves as fancy dancers, giving a very good exhibition.

There was one event which modesty might, but will not, prevent my recording. One evening I noticed that a meeting of the "bachelor club" was announced to take place by moonlight on the sea wall, and secretly thought this a decided class distinction; and for once in my life contemplated the disadvantage of the married state. They brought us some ice cream, however, which alleviated the situation. Events proved that the meeting was really camouflage to hide preparation for a dinner to be given the next evening in honor of the birthday of the director of the expedition.

Before dinner on the following day there was plainly something unusual under way, as was evidenced by the fact that everyone was dressed up in his or her "Sunday best," for which I, entirely unsuspecting, was unable to assign a reason. When we filed in to dinner we saw the table ornamented with candles, a beautiful display of flowers, and a profusion of good things to eat quite out of the ordinary. I was a good deal puzzled, but remembered that the next day was the King's birthday, and thought that someone had suggested a friendly recognition of the occasion. When dessert was to be served a great birthday

cake with a brilliant display of candles was brought in by a special serving maid in appropriate costume, and I was at last enlightened as to the nature of the dinner.

The ever faithful Stoner, my main standby, made a very neat little speech of congratulation, referring to the fact that twenty-five years ago I led the Bahama Expedition, and expressing the hope that twenty-five years hence I would be director of another enterprise of the same sort. Henderson made a very happy little talk, all too complimentary, but nevertheless warming the cockles of at least one heart, and showing that the speaker was a past master in the art of blarneying. The director was at first covered by confusion and much moved by the kindness of these, his pupils and friends. This sort of thing is the highest reward of the teacher and gives him the feeling that his work, although at times seemingly fruitless, is after all worth while. Nothing more surely puts heart into a man than appreciation on the part of his students, although that appreciation be couched in terms altogether too flattering to be taken literally. My feelings on this occasion were best expressed in the words of one of the house-maids, "My, but them was fine words they said to the perfessor!"

After the speeches we had a typical university jollification, with college songs and irrepressible college yells; at which the servants, unused to such manifestations, seemed about to take to the water and swim to the mainland. We learned afterwards that the population on the opposite shore was panic-stricken, and decided that the Huns had taken possession of Pelican Island and were inaugurating their well-known policy of terrorizing conquered peoples.

We heard of this from many sources, and doubtless there was intense excitement among the Barbadians, who were unable to understand how civilized people could make such a hideous racket. The American Consul insisted that our festivities were heard at the consulate, fully two miles away. One thing is certain, and that is that no other of my numerous birthdays has created so serious a commotion. However this may be, it did me a lot of good.

I am glad to record that our stay at Pelican Island was devoid of any anxiety on account of sickness, which speaks well

for the healthfulness of Barbados, and fully sustains its well-known reputation as a health resort. Indeed, I believe that a better place for invalids to regain health and strength would be exceedingly difficult to find. The Island seems entirely free from malaria, that curse of many of the West Indies; nor does yellow fever appear to be known there. The water supply is probably the best in the Lesser Antilles, and a blessing to the people. The trade winds so modify the temperature that the heat is at no time unbearable as it is in our hot spells at home. In Bridgeport itself, with its narrow streets and glaring white coral pavements, it is often too warm for comfort. Outside of the city, however, the heat is not trying and the evenings and nights are delightfully cool.

At Pelican Island we were quite comfortable all of the time, the temperature never approaching that of Bridgetown; and the cool construction of the buildings with their high ceilings, ample verandas and abundant windows and doors, made the place an ideal one to live in.

CHAPTER IV

ZOOLOGICAL NOTES. BARBADOS

VERTEBRATES, CRUSTACEA, ECHINODERMS, AND MOLLUSCA

In the preparation of these notes the writer has merely attempted to give some of the outstanding features of interest to the general naturalist. In many cases the identifications are merely approximate, unless given on the authority of someone besides the writer. In the use of scientific names, the better known terminology of the general text-books and reference books is given in preference to the later names proposed by specialists in the various groups. This, it is hoped, will render these notes more readily available for the general zoologist and student of natural history, although they are lacking in the technical accuracy so highly prized by the specialists.

Mammals.—We paid practically no attention to land vertebrates at Barbados, as they are few and well-known. There is a species of monkey in a small patch of woodland in the northern part of the island, but we did not secure specimens for identification. The mongoose is plentiful and regarded as a pest; and vain attempts have been made here as in other islands in the West Indies, to suppress it. It is said to destroy a good many birds and eggs. The rat of this region is also regarded as vermin by the planter, doing much damage to the cane, and it is quite fond of cocoanuts, gnawing its way through the outer husks and often making its nests in the young fruit. I was told by several reliable witnesses that the rat sometimes falls with the fruit and avoids injury by jumping out just before the nut strikes the ground.

Fishes.—As before indicated, we employed native fishermen and their fishpots with good results. Dr. Barton W. Evermann will prepare a report on the reef fishes. In the present work it is not the intention to anticipate this or any other special re-

port, but simply to give a few notes regarding some of the more striking species that were jotted down by the writer, and his son Willis.

Among the market fish at the time of our visit, the most important by far is the flying-fish, which occurs in great abundance off the coast of Barbados during the summer months. It is a beautiful fish about ten inches long, slender in shape, bright blue above and silver-white below. Quite a fleet of flying-fish boats had moorings near Pelican Island, and we passed these little craft frequently while dredging. These boats are very deep for their size and carry more sail than is always safe. The competition being severe, the boats first reaching the fishing grounds, and then the landing, have here as elsewhere, a decided advantage over their rivals. Their most striking peculiarity is the downward slant of the bowsprit which gives them the appearance of constantly sticking their noses under the water. The fishermen explain this peculiar rig by saying that it gives greater stiffness to the jib-stay, so that it can carry a larger jib (which is indeed often of relatively enormous size) and thus increase the speed of the boat. These craft are often capsized and not seldom sunk by the sudden squalls and heavy seas. In this event there is relatively little loss of life, as the men are almost always good swimmers and can stay up for hours to wait rescue by other boats; or they can swim ashore if the distance is not too great. They sometimes cruise as much as thirty miles from the island, I am told. The method of fishing is peculiar. The bait is in small fragments like uncooked hash and is thrown in considerable quantities on the surface of the water. If a school of flying-fish is in the vicinity, they are sure to discover the bait and swarm around it in thousands, when they are caught in large scoop-nets sometimes many hundreds or thousands being secured in a comparatively short time by a single boat.

After making a catch, the boat runs to the shore in the shortest possible time, and there is great excitement at the landing. The fish are ladled into large hampers holding several hundred each. Then women with immense trays on their heads heaped with the beautiful fresh fish, race through the streets at a dead run, some of them going several miles to the more distant part of the city, crying their wares as they run. Of course the

fastest sprinter sells her cargo first and reaps her reward. Besides these women, who are hucksters of the trade, the various fish markets have their representatives on hand to attend to the wholesale business and thus dispose of the greater part of the fish as soon as possible. It is said that they will not keep any length of time in this climate.

The flying-fish are usually served as pan-fish, being fried, and come to the table skillfully boned and deliciously browned. We thought them about the most toothsome fish-food that we encountered at Barbados. They are retailed to the consumer at from six to ten fish for ten cents, according to the catch.

Attempts have been made to preserve these fish in pickle for future consumption, but with indifferent success, I understand. A curious crustacean parasite often infests the flying-fish, attaching itself to the abdomen and showing as a tuft of dark-colored filaments several inches in length. We have not as yet identified the species. This is undoubtedly the most extensive fishing industry of Barbados, and yields a livelihood during the season to hundreds of men and women. It has been suggested that the abundance of flying-fish in Barbadian waters is due largely to the scarcity of sea-birds that elsewhere feed on the smaller fry. As a matter of fact I have never seen a region with such a small quota of sea-birds as this. They are much more abundant around the islands, such as the Hawaiian group, in mid Pacific; and it is hard to account for their paucity unless it be due to the fact that there are no small islets off the coast, except Pelican Island, which is too near the mainland of Barbados to afford a safe place for a rookery.

Another fish which appears as a staple market-fish and is greatly esteemed, is the dolphin. This is not the mammal allied to the porpoise, but the fish *Coryphæna* which is famed for the beauty of its colors. It is probably one of the most beautiful fishes in the world, and well deserves its reputation. It is interesting from a gastronomic standpoint also, as "dolphin steak" is a well known favorite dish in the hotels at Barbados. We enjoyed it frequently and paid the equivalent of ten cents a pound for it.

On one occasion when we were dredging with the launch off Hastings on the south coast, we found ourselves suddenly sur-

rounded by a school of these fish, and they played around us for ten minutes or more. They are trimly built and excellent aquatic acrobats, gliding beneath and around the boat and leaping sometimes six or eight feet above the water. Their colors were surprisingly brilliant, being in large masses of vivid blue, red, and yellow, simulating animated rainbows as they cruised around us as if on exhibition. Sometimes they struck the steel dredging line, which seemed to surprise them greatly, as they would leap high out of the water, turn over in the air, and strike the sea again with a resounding whack. I do not know its maximum size, but imagine that some individuals that we saw would weigh from thirty to fifty pounds. On one occasion near the Bahamas, I was aboard a schooner when an entire school of about twenty dolphin was caught by hook and line in not more than ten minutes, and the scene on deck was a complete confirmation of all the remarkable stories that I had heard of the marvelous colors of the dying dolphin.

Another good market-fish is the "Horse-eye," a species of *Carynx*, many of which were afflicted with what the natives call the "roach;" an Isopod crustacean of robust form and sometimes nearly two inches long, which fastens near the base of the tongue of its unfortunate victim and must cause great discomfort.

Edible fishes are very numerous in these waters, and our fishpots yielded many specimens. Among them were the leather jack (*Oligoplites saurus*), the rock hind (*Epinephelus adscensionis*), covered with distinct round spots that extend to the fins, the red hind (*E. maculatus*), beautifully marked with bright red spots with darker centers. Several kinds of snappers, including the red snapper (*Neomænis aya*) which is much esteemed; the yellow-tail (*Ocyurus chrysurus*), and many others were secured.

What delighted us most, however, were the many brilliantly colored reef-fishes, a tubful of which was a most gorgeous sight. Conspicuous among these were several kinds of angel-fish, characterized by their compressed bodies and scaly fins. Among these were the rock beauty (*Holacanthus tricolor*), black, yellow, and scarlet in striking contrast; and the blue angel-fish, a most gorgeous creature with yellow and red; and the most in-

tense blue on the jaws, operculum, base of pectoral, forehead, and edgings of the dorsal and anal fins. Two species of butterfly-fishes were secured, exquisitely dainty in their coloration. There were blue and white parrot-fish, three kinds of "tang" and two kinds of "grunt." In one tubful we distinguished at least twenty-five species of brilliantly colored forms.

But the colors are no more striking than the bizarre forms of these fishes about the reefs. Several kinds of so-called "eels," or morays, were secured. When one of these is trapped in the fish-pots there is a lively time aboard. Of all fishes they seem to me the most courageous. Their movements are extremely rapid; they are almost impossible to hold, so slippery are they; and their numerous lance-like teeth are dangerous weapons, often inflicting serious wounds on the fishermen. When in the trap they attack the other fishes most viciously, and when they escape into the boat there is always an exciting scramble to avoid their savage lunges. They are the acme of predaceous fishes.

On one occasion when watching the surf pounding on the outer sea-wall, we saw one of the morays leap suddenly from the foaming crest of an advancing wave and catch a crab on a rock entirely out of the water, and disappear instantly with its victim in its mouth. This is one of the very few instances where a fish will actually leave the water to attack its prey.

The trunk-fishes are among the strangest of tropical forms. We secured two or three species. These have a rigid, bony, box-like body, with holes left for the working of the fins and tail. They are covered with conspicuous spots or reticular patterns in fine lines. We found *Lactophrys triqueter*, *L. trigonus*, and *L. bicaudalis*, or spotted trunk-fish. These are regarded as edible by the natives, although they are far from attractive in appearance. One of the largest specimens was given to our diver, Albert, to take home. He reported afterward that it made his whole family sick, and his graphic account included the remark, "De first mon to spew was the cat!"

The porcupine-fish (*Diodon hystrix*) is common and among the curios most frequently encountered in the shops of the dealers in Bridgetown. Some of them are of considerable size, up to two feet in length, and almost globular in form when

swelled out. The "old-wife" grows to a considerable size and is laterally compressed to an extraordinary degree. It is one of the trigger fishes (*Balistes*) but much larger than any of the others. It is greenish in color with curious diagonal lines of light blue on the sides of the head and the pectorals, and also on the caudal fins. These trigger-fish are so named because the first dorsal has three spines, the first of which is very strong and erect and is "set" by the compression of the second spine. The "old-wife" is regarded as a particularly good food-fish.

Some of these reef fishes are dangerous to the collector, who should be constantly on his guard while working about the reefs. I have already referred to the moray, of which there are several species. Individuals are quite local in their habitat and apt to lurk under masses of coral rock, from which they dart out after their prey or the incautious collector. As said before, they are utterly fearless. Perhaps the most dreaded fish in these waters is the "lion-fish," of which we heard many fearful tales of the fishermen and divers, who are in mortal dread of this creature. One specimen was caught in one of the fish-pots. It is probably a *Scorpaena* of some kind. It lurks among the sea-weed in shallow water and is said actually to attack human beings, inflicting exceedingly troublesome wounds with the poisonous spines of the dorsal fins and particularly those on the preoperculum. It is a decidedly ugly fish in appearance, with enormous warty and tag-like protuberances. The tags, together with the dull blotchy colors render it very inconspicuous while lurking in the shadows. On one occasion Albert had a lively fight with a lion-fish which he attacked under water with his knife, while diving for specimens. The "bat-fish" is another very bizarre form caught in these waters. It is the *Ogcocephalus vespertilio* of writers and attains a length of about twelve inches. It has a brownish back with dark spots and greatly depressed body, and its leg-like fins give it a strangely grotesque appearance. But one specimen was secured and that was taken from a fish-pot.

Taking it all in all, the fish-pots were a good investment, yielding numerous specimens and affording some of the most interesting and instructive experiences of our life at Pelican Island. It is greatly to be regretted that these beautiful speci-

mens entirely lose their colors in the common preservatives and are most unattractive objects after a few hours. Casts and color sketches were taken of a few of these and may yet afford a hint of the actual appearance of some of the tropical fishes.

Balanoglossus was found by Dr. Fisher in digging up the sand in shallow water, though it was not very abundant. This strange protocordate was, in life, much larger than the preserved laboratory specimens that I had seen before. It is exceedingly delicate and fragile and apt to go to pieces during the hardening process. We succeeded in preserving only a few of these problematic offshoots from the ancestral tree of the vertebrates.

Crustacea.—Perhaps the quantity of specimens collected in this group was greater than in any other, as is usually the case. The income of material was so great and constant that Mr. Ensign, to whom the group was assigned, was unable to attempt identification and had to devote himself to assorting and putting them away. Dr. Mary J. Rathbun of the National Museum has kindly furnished the names of most of the species mentioned below, and any mistake in identification should be accredited to the writer. The largest crustacean secured was the well-known spiny lobster or "cray-fish" of the West Indies, (*Palinurus*) and a more striking and gaudily colored creature would be hard to find. Some specimens would probably measure as much as four feet from tip of antennæ to the end of the tail. Although a vicious looking animal, with bristling "feelers" and conspicuous horns and spines, it is really quite harmless and can be handled with impunity, as it has no effective weapons whatever, being devoid of the formidable chelæ of the real lobster or cray-fish. Some of our party took a gastronomic rather than zoological interest in this huge crustacean, and this is excusable when we see the large amount of delicate white flesh that is taken from a fair-sized individual. Greenlaw was past master in the art of catching, as well as of preparing this succulent animal, and most of us were not too absorbed in zoological contemplation of *Palinurus* to resist it when served according to Greenlaw's formula.

One of the most remarkable macrurans in the collection is *Parribacus antarcticus*, differing from the Hawaiian form in our

University collection in some minor details, but evidently identical generically. It is truly bizarre in appearance, being much flattened and having the carapace produced laterally by the great extension of its edges and terminating in rows of stout curved spines. The eyes are very far apart on the dorsal surface, sunken in pits and with extremely short eye-stalks. The antennæ are astonishingly modified, that which probably represents the squamous portion being produced into a great flattened triangular shield, forming what appears to be an anterolateral extension of the carapace with which it is strictly continuous. The rostrum forms a very low triangle with the broad base transverse to the carapace between the antennæ. The body is mottled dull brownish and yellowish and covered with smooth dome-like tubercles, each of which is surrounded by a circle of small stiff hairs. There are no chelæ, all of the legs ending in strong and curved hooks. The specimen is a female and has a total length of seven and one-half inches and a breadth of four inches.

The Anomura are represented by several species of hermit-crabs. The smaller and more abundant of these are known as "soldier-crabs" from their habit of proceeding seaward in large numbers at certain times. A very small species inhabiting the shell of a *Dentalium* differs from nearly all the others of the group in being bilaterally symmetrical instead of twisted to fit the spiral coils of the shell which it inhabits. The *Dentalium* itself is straight, with no twist whatever, and the hermit has adapted its form to this style of habitation. Its chelæ form a perfect operculum, orbicular in form to fit the aperture of the shell. The largest hermit crab that I have ever seen was *Eupagurus granulatus*, collected near Pelican Island, where it inhabits a large gastropod shell, probably a *Strombus*. This crab was thirteen and one-half inches in length, a monster of its kind.

Brachyura.—Big land-crabs were abundant and excellent eating, although we could afford but one mess of these, the specimens being too valuable in collections to warrant us in using them often in the commissary department. Besides there were several in our party who did not take kindly to strange sea-food. For my part, I am truly sorry for those conservative people who have to be brought up upon an article of diet before they can

persuade themselves to like it. The common land-crab of Barbados is *Cardisoma guanhumi*, bluish-gray in color, with a spread of as much as twenty inches from tip to tip of its truly formidable claws. It is exceedingly pugnacious and the collector has to handle it with care if he is to avoid being severely nipped. Our specimens were secured by the negro boys living on the adjacent mainland, who sometimes brought in a dozen or more in a gunny-sack. It is said to be advisable to keep these crabs several days before killing and eating as they are reputed to be scavengers. Dr. Fisher established commercial relations with the boys and thus secured a series of good specimens.

Another and much more common land-crab was *Gecarcinus lateralis*, a considerably smaller species of a bright red color above, with yellow markings and light yellow below. It is exceedingly numerous in many localities on Barbados. While staying at the Crane Hotel on the east coast the preceding year I saw them in swarms among the bushes in a deep ravine near the hotel. Indeed, while at dinner one evening, considerable consternation was shown when one of these creatures walked deliberately across the floor of the diningroom. Perhaps it was the southern equivalent for our northern mouse. These crabs are almost exclusively terrestrial, although their burrows may reach down to the water. The natives have no knowledge of either of these species of land-crabs going down to the sea to breed, and this throws considerable doubt on the theory that they do.

Here as elsewhere numerous species of crabs furnish a wonderful array of protective contrivances of various sorts. One of these was a very fine *Dromia erythropus* with highly vaulted body about three inches broad. It was pinkish in color, with its dorsal surface completely covered with close-set hairs forming a piling which had a velvety appearance. It was entirely covered by a membranous sponge. Another specimen, probably of the same genus, had a huge shield formed by a brownish sponge which extended far beyond the carapace of the crab. Still another *Stenocianops furcata*, has a larger triangular body and conspicuous frontal horns, upon which fleshy cylindrical sponges grow. Several cases were found where two or three living anemones were comfortably ensconced on crabs, thus securing

free transportation; and in one case. *Podochela gracilipes*, a living hydroid (*Sertularella*) was found on the immensely elongated leg of a very slender crab dredged from a depth of about thirty-five fathoms. A specimen of hermit crab, probably *Eupagurus*, had ensconced itself in a large *Livona* shell, upon which were five living anemones, and a *Mithrax* bore on its rostrum a large bunch of green seaweed. A habit often shown by sea anemones had been adopted by a *Mithrax* which had fastened on its back a number of broken bits of shells, thus protecting itself from observation. It came from sandy bottom at a depth of twenty fathoms. Another crab, (*Pitho mirabilis*) had a very light colored surface exactly simulating sand. Practically all of the large genera *Pinnotheres* and *Mithrax* are protectively colored, and they are also much given to bearing sponges on their backs to conceal them from their enemies.

A very large crab, *Mithrax pilosus*, was taken from the seawall at Pelican Island. It had a spread of nearly a foot. The carapace bore many large curved spines, particularly along its edges. The legs ended in strong curved claws and were spiny except on the terminal part of the chelæ. The body was nearly covered with bristle-like tufts of fine hairs greatly resembling the paxillæ on many star-fish. The eyes were very small, dark colored and sunken into pits where they were difficult to see.

As noted before, certain species of crabs lived a semi-symbiotic life near the bases of very large anemones. One, *Mithrax coryphe*, was exceedingly hairy and the carapace was broadly triangular. It is so covered with hair and tag-like tufts as to be very inconspicuous. We had ample evidence that this crab was often captured and devoured by the anemone. Another with similar habits in *Macroceloma subparallelum*, with two horn-like projections or rostral spines just above and between the orbits. Miss Van Wagenen kept a number of these anemones alive for a considerable time and witnessed their successful capture of the crabs which became entangled with the adhesive tentacles of the anemone. She also found fragments of these crabs in the stomachs of their hosts. Here we have an association between very different animals quite similar to that which I described in the Bahama report, page 121, in which a little fish obtains protection by living among nematocyst-laden ten-

tales of *Physalia*, or the Portuguese man-of-war, while the latter takes toll by capturing an occasional fish. I have no doubt that the same relation exists between certain Medusæ and little fishes which live in their gastric cavity.

The coloration of most of the crabs is in general such as to render them inconspicuous in their natural habitat. It resembles the original type of camouflage of ships during the war just ended. It seems evident, however, that the crustaceans adopted the more advanced style of camouflage ages before this world war. Those who have seen the later development in ship painting have been much impressed by the bizarre patterns in sharply contrasting colors that make a vessel look like a crazy piece of patch-work. Black, white, blue, gray, even some yellow and red, strike one as better adapted to advertisement than to concealment. I myself have hardly been convinced that the vessels have thereby been rendered inconspicuous and have been slow to believe that this device is particularly effective. Captain Gladwin of the "Parima," however, tells me that he has found it very difficult to see these ships at night and other times of poor visibility, although he is somewhat skeptical as to the effectiveness of their coloration in broad daylight.

Now it is a fact that sharply contrasting color markings do destroy the apparent outline of a body that would otherwise have its contour betrayed, and this may account for the coloration of certain brightly marked crustaceans. Or these colors may merge together so as to be inconspicuous at a distance, although they are striking on close view. For instance, *Porcellana sayana*, a very gaudy little crab taken from an old *Strombus* shell, was greatly flattened both in body and legs, and its general color was a bright pinkish brown or terra cotta; but the entire dorsal surface was ornamented with sharp round "polka dots" of pure white, each spot being further accentuated by a sharply defined border of deep red, as if to bring the spots into the boldest possible relief. It is hard to explain such a pattern on the principle of protective coloration, but it seems to me possible that at a comparatively short distance these colors might merge so as to be quite inconspicuous on the sea-bottom.

Great quantities and many species of crustacea were secured

by breaking up masses of old coral heads brought up by our diver. These are mostly small species not yet identified. Among them might be mentioned numerous "pistol crabs," which greatly amused us with the sharp clacking or clicking noise made by their chelæ, resembling the tapping of a metallic substance on glass. There seemed to be several species of these and also many shrimp-like macrurans showing brilliant coloration in which deep blues and rich dark reds predominated.

In looking over the almost innumerable specimens of small crabs secured in this way, I am impressed with the prevalence of dark, rather dull, red color in the assemblage as a whole, although I am entirely unable to account for it on any theory of coloration that I know of; unless the fact that it is dark red may help concealment in the probably dim light of the cavities in coral rock which these animals select as their habitat. I noticed also that many otherwise dull-colored crabs are apt to have their chelæ, or pincers, strikingly colored in sharp contrast. For instance, *Ozius reticulatus* is not a conspicuous purplish brown, but has jet black chelæ, while *Mithrax verrucosus* is a brighter pink, but has vivid carmine claws. One of the most conspicuous specimens secured was *Carpilius corallinus*, taken in a fish-pot off Lord's Castle. This was a brilliant carmine with almost black chelæ. The body is orbicular, quite smooth, and about five inches in diameter.

Among the strange forms from comparatively deep water we secured at Station 64, depth about 150 fathoms, a small, exceedingly slender legged spider crab, allied to *Anisonotus curvirostris*, figured by Alexander Agassiz in his "Three Cruises of the Blake," with a triangular body, slender beak-like rostrum, and very long legs. Our specimen is, however, much more slender and delicate than is indicated in Agassiz's figure. The legs are so slender as to be thread-like and bear bristles as fine as the most delicate sponge spicules. Another species of curious form is the *Solenolambrus tenellus*, with very long chelate appendages edged with spines, and the chelæ proper armed with relatively small triangular pincers.

One of the most highly modified crustaceans secured by us was *Cymothoa æstrum*, the so-called "roach" already mentioned as being parasitic on the back part of the tongue of the "horse-

eye" fish. This roach is an Isopod, the largest specimen secured being two inches long and thick in proportion. As one would expect from its parasitic habit, it is entirely colorless, or rather an ivory white. It is also apparently eyeless, another effect of a parasitic life, I suppose; and is provided with seven pairs of remarkably strong claw-like appendages, with which it maintains its relentless grip on the tongue of its unfortunate host. Near the base of each of these appendages is a strong flattened process reaching downward and backward. The basal joint is provided with a strong elevated ring surrounding a cup-like cavity which may act as a sucker to still further insure the fixation of this really terrible parasite.

Imagine the discomfort of a poor fish with such a creature permanently fixed in its throat at the base of the tongue, and holding on with relentless tenacity! A wood-tick eight inches long lodged in a man's throat would convey some idea of the "horse-eye" afflicted with a roach.

The commonest crustacean about Pelican Island, and one of the hardest to secure, was the "Sally lightfoot" (*Grapsus grapsus*). This is an extremely flattened creature of considerable size, some specimens attaining a spread of ten inches, although the carapace is but two and one-half inches wide. Its color is dull dark red, mottled with grayish and yellowish below. The chelæ are brilliant vermilion with white tips. This species was abundant all along the sea-wall built of blocks of coral rock which was a mottled dark gray and earth color from long exposure. *Grapsus* is the liveliest in its movements of any crab that I have seen, scuttling into the crevices of the rock at the least evidence of danger; its thin body fitting snugly into surprisingly small cracks, and dashing about with remarkably agility. Although the commonest crab of the region and almost always in evidence, we found it exceedingly hard to secure specimens. Albert, our diver, was equal to the occasion, however, and would get into the water by the sea wall and show agility equal to that of the "Sally light-foots," thus securing a fine series of this interesting species. The moray, as already mentioned, is equally quick and we saw one pick a crab off the sea-wall fully as expertly as did Albert.

Albert also showed us a successful method of catching the mole-crab (*Hippa cubensis*), of which we desired a supply for laboratory use. These are beach-dwellers on smooth sand, and bury themselves so quickly that they are rather hard to catch. Albert would take a few of the common land-crabs, tear them into fragments, for bait, and scatter them on the sand in front of an advancing wave. Upon the wave receding, specimens of *Hippa* would be found trying to carry off the crab-meat which so occupies their attention that they can be scooped up in the hands or with a crab-net with comparative ease.

Echinoderms.—The most notable fact regarding this group was the scarcity of Asteroidea, both in shallow and deeper water. But one species was found in quantity and that in but one locality off Needham's Point on the opposite side of Carlisle Bay. The species referred to is *Linckia guildingii* Gray. It is deep red above and yellowish below. Like some of its allies, it is peculiar in having two madreporic bodies, and further remarkable for its astonishing powers of regeneration. A complete specimen was an exception in those collected by us, although the species is by no means fragile, being unusually tough and leathery in texture. The rays are much harder to break than in the case with most other species which I have handled. While many forms will occasionally go to pieces of their own accord, I have had experience with only one, *Luidia*, that seems habitually to resort to this method of protest against the ills of outrageous fortune. *Luidia*, however, almost invariably casts most of its rays, even if carefully handled and kept in fresh sea-water; and for this reason it is difficult to secure entire specimens. But this is a very fragile species and the habit of voluntary dissolution is not to be greatly wondered at.

Among the numerous specimens of *Linckia* collected by us, the majority showed regeneration in some stage or other, but none, so far as I am aware, came apart after being captured; and some of them were kept alive in buckets for a considerable time. Every possible stage of regeneration is exhibited in our series, from a single mature ray from which a minute body and five tiny rays are budding, to the nearly complete regeneration of a single ray from an otherwise entire specimen. As it does not appear to disassemble voluntarily on the approach of dan-

ger, it is hard to account for the almost universal evidence of regeneration shown in our specimens. Possibly it has particularly aggressive enemies which bite off the rays or devour the whole animal, leaving but an occasional single ray to form the "comet star" frequently alluded to in text-books. But it may be simply a sort of alternation of generations by which a single animal may multiply itself by five without resorting to sexual reproduction. Whatever the explanation, I know of no other Echinoderm showing the process of regeneration so completely as does this *Linckia* from Barbados.

Lang, in his Text-book of Comparative Zoology, volume 2, page 506, says that in the *Linckiidae* "the arms become constricted off at their bases, after which not only does the disc regenerate the arms which have been cast off, but each individual arm regenerates the disc and the other arms." One cannot help speculating as to whether there is any relation between the possession of two madreporic bodies and this excessive power of regeneration.

The familiar *Oreaster reticulatus* is said to occur at Barbados, but no specimens were secured by us. The fishermen told me that it feeds on the big conch *Strombus gigas*. Dr. W. K. Fisher, who will report on the Asteroidea of the expedition, has identified the following species from our Barbados material: *Asterina folium* was found under rocks near Pelican Island, where it resembled corraline spots on the nether side of stones. *Rosaster alexandri*, *Luidia barbadensis*, and species of *Plinthaster* were also noted. On the whole, we were greatly disappointed at the scarcity of Asteroidea at Barbados as compared with other parts of the West Indies. Perhaps the distance from the Continent has something to do with this paucity of forms, although this explanation lacks plausibility.

Echinoidea.—The most abundant sea-urchin in this region is the white "sea-egg," *Tripneustes esculenta*, regarded as a very important source of food by the Barbadians. Some specimens grow to relatively great size, being six inches in diameter, although the average is only about three and one-half inches. There are two apparent varieties which do not seem to correspond to either sex or age and may occur side by side in the same area. One is entirely white, while the other has pure white spines,

but black pedicellariæ, forming very distinct black meridional zones. The white form is less common than the other, and both are recognized by the natives, who consider them different "kinds" of sea-eggs. The spines are short, smooth and comparatively blunt, but the fishermen say that they are more poisonous than those of the "black sea-egg," or *Diadema*, although they penetrate much less easily than the latter.

This urchin is common in many places along the coast. We found it quite abundant near Pelican Island on the sandy bottom, and in 1918 I found them very numerous off the Crane Hotel and Lord's Castle on the east coast. Enormous quantities are taken for food, and so great is the demand that the Colonial Government has instituted a closed season for them. This does not deter the native from taking them at all times; although they are not served at hotels during the closed season, which is in the summer months.

The gonads, or ovaries, are the part eaten, and my divers would come up with an armful, then sit in the boat in a state of nature, crack open the test, skilfully scoop out the other viscera, leaving the orange-colored ovaries *in situ*, and removing all five of them with a single scoop of the hand, plump the whole mass into their capacious mouths with immense satisfaction. These ovaries really appear appetizing as they lie in the white shell, and are much less repellant than live oysters, which are esteemed by civilized man. As served on the hotel table, the sea-egg is a favorite dish in Barbados, and this is the only place where I have seen it used as a regular article of diet on this side of the Atlantic. At Naples, Italy, an allied species is used as food by the common people, although I never saw it served at hotels there.

We were asked to investigate the sea-egg at Barbados with a view to suggesting the best means of protecting it from extermination, which seemed to be greatly feared. Dr. Job found that the ovaries were just becoming mature in May. He believes that the small fry of fish consume great quantities of the larvæ and that the best way to protect the sea-eggs would be to introduce hatcheries similar to those used in the lobster hatcheries conducted by the United States Bureau of Fisheries. Possibly an area could be enclosed in fine wire mesh, in which a number

of sea urchins could be placed in the breeding season, where they would be in their natural habitat and the larvæ could pass through their pelagic development without the invasion of predatory fish. Dr. Job also believes that it is possible to discriminate between the sexes of this species by means of external features. He advocates that certain large beds be protected by a closed season every alternate year, thus allowing them a biennial season for recuperation. There is no doubt that this sea-egg is a valuable food product, being exceedingly nutritious and quite palatable; and it is now the basis of an industry of no mean proportion, and might by judicial legal and scientific encouragement be greatly enlarged, much to the advantage of our friends, the Barbadians. A laboratory for the scientific investigation of the problem of protection, based on a better knowledge of the life history of the species, could easily be established in one of the unused buildings on Pelican Island, and this could be done at very small expense and pay for itself many times over in a rational control and encouragement of the industry.

My own limited experience with the sea-egg as a food would indicate that it is quite palatable and doubtless nourishing; but too concentrated to make it wise to partake of it in quantities. The natives, however, who eat it raw seem to feel no impulse to restrict themselves and apparently suffer no ill effects.

Still more conspicuous is another sea-urchin known as the "black sea-egg" and called *Centrechinus antillarum* by Dr. Clark. I feel, however, like entering a protest against abandoning the firmly established name of *Diadema* for this genus, and believe that it is one of the cases where long and practically universal usage establishes a just claim against an obscure priority.

No one goes bathing or into the water for any purpose in this region without being warned against the danger of being wounded by the cruel black spines of this ubiquitous sea-urchin. It is found almost everywhere in shallow water, both on sandy and rocky bottom. Its habit of partly or wholly concealing itself in depressions in the rocks or under the edges of coral heads makes it all the more dreaded by bathers, divers and fishermen. The spines are slender as needles and sometimes at-

tain a length of seven inches. They are so sharp that they will penetrate shoe-leather, and instances are related where they have pierced entirely through the human hand or foot. Moreover, they are as brittle as glass, always break off in the flesh of the victim, and are provided with minute whorls of long scale-like barbs, pointed forward so as to make a lacerated wound. These spines cause a burning itching pain which for a time is quite severe, and often there is a pronounced numbness of the arm or leg which does not, however, last very long. A broken fragment can not be pulled out and is apt to cause a festering sore which is quite troublesome, although not likely to be dangerous, and ultimately the spine seems to be dissolved or at least disappears. The best method of treatment is said to be the application of grease of some sort, which helps to loosen the fragments of spines, which then come out or are absorbed. Several of our party were wounded more or less severely by this black nuisance, and all learned to have a wholesome respect for its spines.

Dr. Hubert Lyman Clark says that in spite of its being one of the most familiar of all West Indian Echini, it has never been adequately figured. This is doubtless on account of the great difficulty in securing specimens from which most of the spines have not been broken off.

In my "Bahama Expedition" experiments are described by which a direct thrust of these spines is demonstrated. Similar, but not very extensive experiments at Barbados, gave negative results. There is no doubt that this species can see after a fashion, as it is able to detect the approach of a human hand or foot, as is evidenced by the action of the spines.

Echinometra viridis is another very common form found abundantly in shallow water under stones, where it is often associated with the serpent star, *Ophiocoma echinata*. *Echinometra lucunter* is also found, but is less common. It is dark colored and the spines on the ventral surface often have a violet tinge.

Among the species obtained by dredging, perhaps the most attractive is *Cælopleurus floridanus*, with its exceedingly long and flexible spines of brilliant carmine and white, and the broadly contrasting zones of dark brown and violet, or, in some

cases, chocolate and orange yellow. The delicate spines are very active at times, when first taken from the water. Another very beautiful species is *Salenia pattersonii*, with vermillion and white spines. Several specimens allied to *Cidaris* were secured, among them probably *C. tribuloides*, and *Dorocidaris papillata*.

Only one species of spatangoid was taken, *Echinoneus semi-lunaris*, brown in color and with the ambulacral grooves extending all the way around to the mouth. There are four genital pores, and both mouth and anus are ventral. This species lives buried several inches in the sand beneath rocks. Fisher was the first of our party to discover its habitat.

Dr. Fisher has kindly supplied the following notes regarding the Holothurians: One of the commonest littoral forms at Pelican Island was *Holothuria arenicola* which occurred under water-worn beach rocks at high-tide level. The animals were buried in the sand, head downward, in such a way that the rocks formed a protection above them. Normally, the anal aperture was at the surface of the sand just where the latter met the stone. These sea cucumbers were found in a narrow zone at mean high-tide level, so that an ordinary slight degree of low tide would uncover them. In the same narrow strip grew a sparse filamentous green alga attached to the beach-worn rocks. Under each stone the holothurians were sometimes fairly crowded. This species like many of the fossorial forms, has a narrow circle of small tentacles, is rather tolerant of abuse in "killing mixtures," but care must be taken to kill them expanded.

Synaptula vivipara.—Dr. Fisher states that in digging in a patch of eel-grass for this species he found only one specimen, whose head was subsequently lost, so that the record is not certain. A good deal of digging was subsequently done, both at Pelican Island and at Antigua, for this form; but no other specimen were found.

The *Ophiuroidea* of the expedition will be reported on by Dr. Austin H. Clark of the National Museum. The following notes were taken in the field. By far the most abundant species was *Ophiocoma echinata*, which occurred almost literally under every stone and scuttled away with amazing celerity when disturbed.

It is most commonly brown in color, with the club-shaped

spines almost black. The disk showed great variation, often having a central oval or pentagonal area of cream color showing in sharp contrast to dark brown spines.

A species of *Ophiothrix*, with its long glassy greenish or bluish spines beset with thorny spinelets, fairly swarmed over some of the gorgonians brought up near Hastings by our diver. Often the large, profusely branched gorgonians were fairly covered by the wriggling ophiurians. Besides *Ophiocoma echinata*, *O. riisei* and *O. pumila* were secured, but are much less abundant. A very peculiar specimen was dredged at Station 10. It seems to be an *Ophiura*, much like *O. cinerea*, but is over a foot in spread. The disk is elevated in the center so as to be conical in profile.

One of the most beautiful serpent stars that I have ever seen was taken at Station 64, depth 60 to 70 fathoms. It is doubtless an *Ophiothrix*, having the pierced jaws; glassy, jagged spines and no mouth papillæ of that genus. It is a large specimen with a spread of about ten inches, with a very distinct band of vivid crimson on a background of light pink along the dorsal surface of the arms and extending to the center of the disk. The arm spines are very slender, eight mm. long, quite transparent, with saw-like sides and in three series on each side of the arms.

Here, as on the Bahama trip, we were greatly interested in the assemblage of forms of simple-armed basket-fish. Perhaps the most conspicuous and strikingly marked of the sparingly branched forms is the *Astrocnida* from deep water. The arms in the small specimens are unbranched, while those of the larger specimens from Station 89, depth 80 fathoms, are slightly branched at the ends and ornamented throughout with transverse elevated bands of light gray alternating with depressed bands of deep chocolate. These circular ridges are beset with thorny stubby spines as in *Astrogomphus*. The bases of the arms are swollen and the swellings invade the dorsal surface of the disk, in the center of which is a star-shaped area formed by similar ridges. Another simple-armed basket-fish is from Station 7, and is orange colored and exceedingly hispid all over, feeling like coarse sandpaper, wiry in texture, with arms tapering to a mere coiled thread which can wind itself closely around

a support and cling there most tenaciously. A certain flabellate red and white gorgonian was very common in the dredging and almost always a species of simple-armed basket-fish was coiled closely around the branches, which it matched so perfectly in color that it was very apt to be overlooked. The protective coloration is so commonly found in serpent stars living as symbionts on alcyonarians that many writers have noticed it. Alexander Agassiz says in his "Three Cruises of the Blake," volume I, p. 310:

"Among the abyssal invertebrates living in commensalism, the adaptation to surroundings is fully as marked as in shallow water. I may mention especially the many species of ophiurians, attached to variously colored gorgonians, branching corals and stems of *Pentacrinus*, scarcely to be distinguished from the part to which they cling, so completely has their pattern of coloration become identified with it."

The subject of the coloration of deepsea animals has long had a deep fascination for the writer, who has used the facts as going to prove, not the recent migration of these forms from shallow water, as believed by Agassiz; but the presence of an abyssal light which would render these colors effective; and the light he believes to be the well-known phosphorescence so abundantly demonstrated in deep water. Animals living in absolute darkness are invariably colorless, as in the case of blind fishes, salamanders, etc. of the underground waters in caves.

A small ophiurid with very long arms and minute disk bearing conspicuous radial shields, had three series of club-shaped arm-spines, a very conspicuous madreporic body, tooth papillæ, and a curious flap-like plate overlying the basal upper arm-plates. Several simple-armed basket-fish allied to *Ophiocreas* were taken; and, intergrading between the ordinary serpent-stars and this, is an *Ophiomyxa* from shallow water.

A species with branched arms, new to me, was from Station 36, southwest of Carlisle Bay. The radial shields are very large and tumid, crossed by conspicuous rounded corrugations which are wavy in places. There are no spines nor evident granulations on the disk, and the specimen is smaller than the other branched forms secured. Several specimens of *Astrophyton*

were found, mostly from shallow water. They appeared to be *A. costosum*.

Crinoidea.—Much to our disappointment only one stalked crinoid was secured, and this was a *Rhizocrinus* from Station 4, depth 110 fathoms. It had a very slender stalk, a small head and no cirri. *Pentacrinus* is found in the region, as I saw a fine specimen in a local collection which had been sent to the British Museum and identified as *P. decorus*.

But the lack of stalked forms was largely made up for by many beautiful sessile comatulids. These will be reported on by Mr. Frank Springer of the United States National Museum. Not being acquainted with this group, the present writer will have to satisfy himself with a mention of some of the wonderful colorings displayed by these graceful but fragile forms. Unfortunately, these vivid colors are exceedingly evanescent, disappearing after but a few minutes of immersion in alcohol. Some specimens must have been as much as 16 inches in spread, and when alive and uninjured presented a truly magnificent spectacle. As a whole, they seemed much more brilliant than the forms encountered on the "Pentacrinus ground" off Havana and on the Pourtalés plateau by the Bahama expedition. Few marine animals are harder to secure intact than these, as the very fragile arms are almost sure to be broken in dredging, either with the dredge or tangles. We secured a number of perfect specimens by taking them from the crannies in large coral rocks brought up from time to time in the dredge. Here they had been protected and could be taken out without injury; but their colors, alas, soon vanished in preservatives. This habit of living in excavations in rocks has not, so far as I am aware, been mentioned by previous writers; but it was quite the usual thing off Barbados. We often found these crinoids far in the interior of masses of old coral rock brought up in the dredge, and we were careful to break such rock very thoroughly, as fine comatulæ were often found within a cavity in the very heart of such masses.

It is hard to imagine the use of these brilliant colors in a habitat such as this. Of course the rocks themselves were often brilliantly colored by the assemblage of corallines, sponges and gorgonians with which they were overgrown. The predom-

inating colors of these were red and yellow, which also characterized the comatulids as well. I find the following colorations of free crinoids mentioned in my notes: "yellow and white; yellow and red; purple and white; black arms, with yellowish pinnules; rich deep vermillion, with bright yellow pinnules; lemon yellow, with black upper surface to the arms; grayish in color; violet in tinge; a crimson crinoid arm; black, with greenish yellow arms; magenta, with dark yellowish arms; one specimen very dark gray, almost black, with whitish cirri."

It is almost certain that a thorough exploration with dredge and tangles off the north and east coast of Barbados would yield a rich harvest of crinoids, both stalked and free. Dr. Austin Clark tells me that stalked forms can be collected by diving, off the coast near Bathsheba. The surf was so high during our entire stay that we could not trust Mr. Henderson's twenty-seven foot launch in these dangerous waters. During late summer and early autumn, the sea is often calm for a week or more at a time, and it would then be possible to work there with a launch. Otherwise, a boat of considerable size would be required. I often longed for the good old "Emily E. Johnson" which we used so successfully on the Bahama expedition. She could do good work off the windward coast of Barbados.

At Station 11, depth 67 to 70 fathoms, we secured twenty-four fine comatulids at a single haul. Several times we brought up what we took to be arms of *Pentacrinus*, but of this we could not be sure. Perhaps they will be identified when the collection is reported on.

Mollusca.—The following notes have been kindly prepared for me by Mr. Henderson:

The conchologists of our party were disappointed in Barbados with the returns from the beaches and other water-margin stations. This is not an unusual experience of northern visitors to tropical places, and is because of the barriers of coral reefs on the usual rough rocky bottom just off shore. As a matter of fact the littoral molluscan fauna of Barbados is poor, both in species and in number of individuals. This is owing to lack of proper stations; the shores are very much exposed to rough seas and strong currents and there are no sheltered waters. On the windward side of the island, where a heavy surf

constantly breaks only the hardiest of *Neritas*, a few *Litorina zigzag* and *Tectarius* and some *Chitons* can stand the destructive force of the waves, and many of the Antillean species usual in exposed or semi-exposed stations are wholly absent. On the leeward side where the surf is less strong there are more mollusks to be found, but even there the in-shore conditions are not very favorable. The southern shore between the Eastern and Needham Points offers the best opportunities to a patient beach-collector who must not tire of gathering quantities of little green *Neritina viridis* and the porcellaneous brown and white *Olivella jaspidea* while searching for rarer things. The ten or fifteen species found washed up on the sand live in the weedy patches among the coral reefs that thickly beset the coast and are difficult to collect alive on account of the dangers of navigation amid the reefs.

Although the general fauna of the littoral zone is poor as a whole, there are a few very interesting species that occur here and that are very rarely taken elsewhere. One is the rather abundant *Voluta musica*, the show shell of the Barbados dealers, which lives in the weedy patches inside the reefs on the western side of the island. Barbados is the metropolis of this very handsome mollusk which ranges along the north shore of South America from Brazil to Cartagena, but for some reason it has never followed the currents further into the general Caribbean region. There are several volutas in Brazil and further south and a rather fine series of them (of another group) in the Gulf of Mexico and Gulf Stream area, but the Antillean island region has none save this unique *Voluta musica* in Barbados. Another very fine Barbadian mollusk, only known elsewhere by three defective specimens, is *Terebra texana* Dall. The type is from Matagorda, Texas, a beach worn specimen and a fragment, and one other specimen is known from the kitchen middens of Brazil. The terebras of the Atlantic have small and uninteresting looking shells for it is essentially a Pacific genus. There the shells of many species are large and very handsome. This particular species, however, is as large and fine as most of the Pacific ones. In past geological times quite large terebras lived in Antillean waters and this is probably a survivor. We did not ourselves actually collect a specimen but one bought

from a curio dealer in Bridgetown is at once identifiable with the Texan type and agrees with specimens in the Rev. Dr. Watson's collection taken from the muddy bottom of the dredged inner harbor of Bridgetown. The apparently curious distribution shown by Brazil, Barbados and Matagorda, Texas, is not unique for the faunal relationships of the mainland coast (including Barbados, the small islands along the Caribbean coast of South and Central America) even to the mouth of the Mississippi are closer than at first appears.

A third rather startling species of the inshore waters of Barbados is the fine *Scala pernobilis* F. and B. Specimens are taken occasionally in the fish-pots. Unlike the last two species it possesses a more general Antillean distribution being taken from the Gulf Stream even to Cape Lookout, North Carolina, but the species is exceedingly rare. It is an extraordinarily fine shell that belongs to a group apparently better represented in Tertiary than in modern seas.

Certainly the most interesting mollusks of Barbadian waters and the ones we most eagerly sought are the two pleurotomarias, *P. quoyana* and *P. adansoniana*. The four known living species of this very ancient genus or family are distributed, one in Barbados and Yucatan, one in Barbados and Guadeloupe, one in the Moluccas and one in Japan. Such a distribution can only be accounted for by the fact that these are but the last surviving remnants of a once almost universally distributed group dating back even to the Carboniferous. Of the finer of the two species (*adansoniana*) we took but a fragment off the Lazaretto in 90 to 100 fathoms, and of the other we obtained a fairly good example off the Spring Gardens in 100 fathoms, and a fragment off the Lazaretto in 100 fathoms. It is quite probable that these mollusks live among the rocks of dead and submerged coral reefs about the 100 fathom line and are therefore very hard to get in a dredge. Their curious anatomical features, their very ancient lineage, their very local occurrence in a world-wide distribution and finally their odd appearance and beauty of shell, make them great prizes to the collector and student. We are told that the fishermen occasionally capture a specimen in their fish-pots and sell it for a very large price.

Our dredging was all done between Hastings and Holetown.

We found the deeper water just offshore much richer in species. An intermediate zone of from 5 or 6 to 30 or 40 fathoms is the dwelling place of numerous forms including some of these found dead on the shore, but the bottom is of so rough a character that no satisfactory work could be done with the dredge. Below 40 fathoms patches of coarse sand appear between rocky areas. These smooth places seemed almost devoid of life, but often yielded the dead "bones" of the rock-dwelling mollusks. At 60 to 70 fathoms the sand patches are more continuous and of finer grain, the rocky areas becoming less; at 100 fathoms the sand is very fine, almost soft and the rocks have quite disappeared. Thence to 120 or 150 fathoms narrow streaks of gravelly bottom are met and the sandy floor becomes quite soft. At about 50 to 70 fathoms the character of the molluscan residents undergoes a very decided though not wholly abrupt change. The littoral and sub-littoral species, *Strombus*, *Fasciolaria*, the large murices, *Oliva*, the cypræas, tritoniums, the littoral columbellas and marginellas, etc. all disappear and are replaced by the Archibenthal zone forms. These are the turrids (Pleurotomids) the scales, the smaller murices, cones, the deeper water species of *Marginella*, *Columbella*, *Nassa*, *Mitra*, etc. and the host of smaller mollusks making up the families of the pyramidellids, the triforids, the cerithiopsids, the rissoids, trochids, etc. The dentalia and caduli gradually increase and the bottom becomes covered with the dead shells of pelagic pteropods. It was from 70 to 120 fathoms that we made our best hauls for mollusks and doubtless could we have reached 200 fathoms we should have found even better collecting.

The soft sand bottom at about 100 fathoms we called the "Cerithiopsis ground" on account of the vast quantity of *C. crystallina* Dall it contained.

Our knowledge of the mollusks from Barbados and the Lesser Antilles, excepting of the purely littoral forms is yet quite imperfect. From Barbados we have the results of a few hauls made by the U. S. Coast Survey Steamer "Hassler" in 1872 off "Sandy Bay" in 75 to 100 fathoms, and a few more by the Fish Commission Steamer "Blake", in 1879 in 6 to 400 fathoms. This material, a small collection at best, is in the U. S. National Museum and the Harvard Museum.

The position of Barbados makes any collection from there important in the study of geographical distribution. The several elements that, taken together, form the comprehensive "Antillean fauna" might be expected to find a common ground in Barbados. The northerly drift from the Brazilian coast should cause a certain Brazilian element in Tobago, Barbados and the line of islands north. This is the case only as to Barbados. The westerly drift from the Atlantic across the line of the Caribbees into the Caribbean (to pour out again in the great Gulf Stream) might be expected to convey the Barbadian mollusks to the shores of Central America and thence to Florida and the Gulf of Mexico. This is partially the case. From Barbados, as a sort of common station, we may trace two quite distinct elements in the Antillean mollusk fauna and these might be designated the Antillean *island* element and the Antillean *continental* element. The first contains less of the Brazilian influence and represents the true "Antillean" fauna (Lesser and Greater Antilles, Florida Keys, Bahamas, Gulf Stream to Hatteras); the second is a continuance of the Brazilian elements along the north shore of South America,—the Central American coast and Texas to the Mississippi River—though modified by inclusion of true Antillean species.

In 86 fathoms, due west of the Cable Station, we obtained a single, but living, specimen of an *Ovulum* which is scarcely separable from the *Ovulum carnea* Poir, of the Mediterranean. This is the first record of a true *Ovulum* from the West Atlantic. The fact of its closeness, or even identity, with a Mediterranean species, is suggestive and interesting. The equatorial drifts from Africa to Brazil must have had some important bearing upon the Antillean marine fauna. There are many Mediterranean, East African and Antillean mollusks that show a relationship, but none that according to modern acceptances of a "species" are quite positively identical. The late Tertiary of Italy and the Mediterranean region does, however, contain a surprising number of species exceedingly closely allied with the living species in the West Indies, and one might almost say the origin itself of our Antillean fauna is found in the Pliocene of Southern Europe. The living Mediterranean fauna is less

closely allied. Our little red *Ovulum carnea* is an important link.

The Barbadian scaphopods include about 16 species, representing several subgenera. Four of the five caduli are only Barbadian as so far known. The most striking of the dentalia is *D. stenoschizum* P. and S. which possesses an exceedingly long apical slit, quite a fourth the length of the shell. *D. laqueatum* described by Verrill from Cape Hatteras and a very abundant species off the Florida East Coast, appeared in our dredge. Without any intervening records this becomes a very long distributional leap. The only Antiguan scaphopods we met are two caduli, both new species.

Almost every haul of the dredge made in rough ground brought to our collection some brachiopods. Probably the commonest was the little *Argyrotheca rubrotincta* Dall which cling to the fragments of coral rocks and dead shells and seemed ever-present like little pink or red pendants on the dull background of their abodes. Another species of the same genus much less abundant, *A. lutea* Dall. is found off the Florida Keys and even to Hatteras. We have it from 12 stations (all Barbados) 33 to 100 fathoms. Very abundant was *Terebratulina caillieti* Crosse, a species ranging from Florida to Rio. We have 35 lots. The method of attachment to stones in these Brachiopods is so very different from that of any bivalve mollusks that they are quickly recognizable. One always feels a sense of awe in collecting these survivors of the past ages. Their antiquity is remotely ancient, even to the Cambrian, and their course of existence is probably run out. At one time they represented a most important element in the total of life on earth,—now they are reduced to a few species scattered about the world and occupy a most subordinate place in any faunal census. That they should have survived at all through such countless ages is probably due to their very wide distribution.

A few dead specimens of *Liothyriana* ("Terebratula") *cubensis* Pourtalés were encountered in 90-100 fathoms, Barbados. This beautiful brachiopod clings in clusters like greenish hued grapes to the stones of the Pourtalés Plateau off the Flor-

ida Keys. No doubt it is also very abundant in Barbados but we did not have the good fortune to fall upon a favorable station.

Had we been equipped with surface tow-nets it is likely we might have added some living pteropods to our collection. In practically all our stations in blue water we took quantities of the dead tests of these pelagic mollusks. In some places the ocean bottom must be very thickly strewn with these glassy bizarre looking little shells. We collected ten species in all, mostly in quantity and often in very fresh and perfect condition. Seven species of *Cavolina*, one of *Cuvierana*, and two of *Clidorea* registers the total. Strangely enough we took no examples of *Limacina*. The number of possible recorded species we might have seen is about twice our actual catch but the average for a field of operation so exceedingly small as ours is remarkably good. The most striking species we obtained (only five specimens) is *Cavolina tridentata* Forskal, a veritable giant among the other species of our catch. It has the great range of the whole Atlantic from the north to the south forties.

Although our main efforts were directed toward marine work the land mollusks were by no means neglected. Whenever anyone went "ashore" he was always on the lookout for land shells and in both Barbados and Antigua we succeeded in collecting most of the recorded species. As compared with the extraordinary richness of molluscan life in Cuba, Jamaica and the other islands of the Greater Antilles,—a faunal wealth scarcely equalled elsewhere in any part of the world—the Lesser Antilles possess but a scant fauna. It not infrequently happens, however, that individual species are quite abundant.

Barbados being truly an oceanic island separated from all other land by sea depths of over 1000 fathoms, we might expect to find thereon a mixed lot of land shells derived from other island and the near-by continent; the number of "Barbadian" species, if any, would depend upon the length of time of their isolation in the Barbadian environment. Among the first species to be observed was the large *Strophocheilus* (*Borus*) *oblongus* Mull., one of the several importations from South America. This big snail lives abundantly all over the island especially in gardens. During the dryer portions of the year it buries

itself in the soft earth of cultivated gardens or flower beds, along the base of walls,—especially in corners, or under hedges. When so buried only a bit of the pinkish tip shows above the ground. During the rainy season the big fellows “fare forth” and are a common and familiar sight. Many of them are crushed under the wheels of vehicles. Like all the members of this South American genus, this snail lays eggs that can only be described as enormous when judged by usual molluscan standards. These eggs,—or the remains of their white calcareous shells—are noticeable on the ground of most gardens throughout the island. Much less abundantly than the last we took in Bridgetown an *Oxystyla* which has been referred to the common Antillean *O. undatus jamaicensis* Pils. Our specimens with their fine narrow longitudinal stripes and deep brown columellar area seem more nearly related to a South American group. No descendants of the Jamaican specimens that Colonel Fielding liberated on Pelican Island in 1889 remain to-day. Another South American importation that we encountered, though rather sparingly, among the deeply weathered limestone rocks is *Streptaxis deformis* Fer. This curiously misshapen little shell suggests having been moulded of some plastic material and left out to dry and harden in the sun but unable to support the weight of its own upper whorls it sagged over and finally hardened or “set” in distorted shape. They are predaceous carnivorous mollusks that probably subsist largely upon other more peaceful mollusks. A more truly Antillean element in the fauna is reflected in the *Pleurodonte (Caprinus) isabella* Fer. which is the characteristic Barbadian species of this Lesser Antillean subgenus. We constantly found dead and worn specimens and had quite given up hope of ever taking the snail alive when one day in a damp ravine of the Scotland District while examining dead leaves of the bread-fruit tree we found quantities of them thus hidden for their period of aestivation. The shell is very handsome, of a dark mahogany or chocolate color. It was always a pleasure to collect. We later found many fine specimens in the patch of ancient forest—the last remaining primitive forest—in the island. It was there also that we found in abundance upon the trunks of a smooth-bark tree the very pretty little *Helicina fasciata sub-*

striata Gray. In Sir Gilbert Carter's grounds we found the European snail, *Eulota similis* Fer., no doubt an introduction by some human agency. There also we found the widely distributed *Bulinulus exilis* Gmel. which in Barbados takes on a very considerable range of color variation. Of the less conspicuous species of the genera *Opeas*, *Subulina*, *Thysanophora*, *Vitrea*, *Leptinaria*, *Succinea*, *Urocoptis*, *Truncatella* and the fresh water pulmonates we obtained nearly all recorded in the several published lists of the island.

CHAPTER V

ZOOLOGICAL NOTES, CONTINUED; GEOLOGY OF BARBADOS

LOWER INVERTEBRATES AND INSECTS

Annelids.—A harvest of marine worms was secured by breaking up masses of dead and even living coral. These were usually brought up by our diver, or taken at low tide near the laboratory. Pounding this rock to pieces was not altogether an agreeable task, but it yielded good results. Miss Catherine Mullin had charge of the Vermes of the expedition, and the worms were at once turned over to her for examination and preservation.

The most conspicuous form was a polychæte, known to science as *Eurythoa pacifica*, and to the natives as the "sea scorpion." It is a very large and formidable looking worm, often a foot or more in length, rather flat, plainly segmented, light orange in color with much darker reddish orange parapodia. It has a hairy or wooly appearance, due to the conspicuous tufts of transparent spicule-like setæ born on each notopodium. There were hundreds probably, in each tuft. Individually, these setæ were exceedingly slender, sharp, usually smooth, but sometimes with serrated sides, perfectly glassy and transparent when viewed under the microscope, and slender as the finest thread. The eyes were blue in color and easily seen on the prostomium.

These animals are much dreaded by the natives, as the sharp slender setæ penetrate the human skin at the lightest touch and appear to convey an irritant poison that is quite painful. They lurk under the rocks and were often uncovered by parties collecting at low tide when feeling about the little pools left by overturning the stones. Miss Mullin also reports that they were found in coral stone where there seemed to be no openings large enough to permit of their passage. She believes that they

make their way into these masses when young and live there until too large to pass through the small apertures that admitted them in the first place. They were also found in old conch shells. The glassy spicules easily become detached, and the bottoms of glass dishes in which they were killed were often covered with a frosting made by thousands of these spicules which had fallen off. Several of our party had very sore fingers from handling the "sea scorpions," and sometimes their hands were made numb for several days. The first effect is much like that caused by handling the cactus known as the "prickly pear." The setæ can sometimes be removed by scraping with a knife, but they usually caused discomfort for several days.

As a matter of fact, our fingers and hands were in bad condition for a considerable portion of the time. Between the needle-like setæ of these worms, the innumerable glassy spicules of many of the sponges handled almost daily, and encountered also in raking over the sand secured in dredging; and the ugly spines of the "black sea-egg" (*Diadema*), we were constantly having sore fingers. Some of us wore rubber gloves and saved the hands, but most of the party found that these rather clumsy contrivances interfered with our work; or else excused our lack of forethought on that plea, and suffered accordingly.

Another interesting annelid was secured by me when collecting off Lord's Castle on the east coast the preceding year. It inhabits a large, very dark red, fleshy sponge which is covered with rough points and reticulations like the surface of the large starfish *Oreaster*. This sponge was very tough in texture and could hardly be torn apart with the hands, but had to be cut with a knife. The annelid, which probably is *Laodice furcata*, lives in tunnel-like passages in the sponge, which are frequently branched. The worms were yellow in color, very long, sometimes as much as eighteen inches, and difficult to extract entire from the sponge, as they broke very easily. Sometimes, by turning the cut surface of the sponges to the hot sun, these worms would come out of their own accord.

The most curious thing about them, however, was the long tubes of parchment-like consistency with which they lined the tunnel-like passages in the sponge; showing that the worm lined the passages through which they wandered, and not simply a

portion long enough to cover the length of their own bodies. I sent some of them to the National Museum, along with other specimens collected at the same time, for identification. In one bottle I sent also a portion of the worm-like tubes in the sponge. This has not been returned and I am not at all sure that the annelid is *Laodice furcata*, as indicated above. The tubes were not only forked, but much twisted and tied in knots as it were, making it still more difficult to secure the worms.

Cirratulus melanocanthus is a tube-dwelling worm with a large tuft of exceedingly slender tentacles, also collected off Lord's Castle. A form which I take to be a sipunculid, is often found imbedded in hard coral rock in cavities in which it fits as into a mould. It is short, ovoid in shape, with very hard leathery integument, transversely wrinkled in some cases, longitudinally in others.. The larger, posterior portion of the body is light buffy in color, with perfectly rounded brownish dots in the center of which are light nodules, the whole resembling the small tubercles of certain sea-urchins. On the anterior, darker and more slender part, there are larger and more closely aggregated rough tuberculations. This is also true of the larger, more abruptly rounded posterior part of the animal. The proboscis is completely introverted in retraction; its extensibility is, however, quite remarkable, and when extended it shows a terminal crown of light-colored brown tentacles; posterior to which are two annular sharply raised ridges or collars. The proboscis is also furnished with numerous denticles or horny nodules of brown color. The body wall is remarkably tough in texture, like strong parchment, and the body cavity contains a curious structure that I have not seen elsewhere among worms; but that reminds one of the ossicles in the "lantern" of certain holothurians. There are three hard broad horn-like plates placed horizontally and making a partial partition in the body cavity. These are fastened firmly to the adjacent body wall and appear to furnish attachment to strong muscles employed in the retraction of the introvert. This worm appears to be allied to *Phascolosoma* of northern waters. One specimen which may belong to a different species, is characterized by having numerous transverse rows of microscopic hooklets on the proboscis, and some distance behind the tentacle crown, all of the hooklets

pointing forward. A similar arrangement of minute hooklets is found on the darkened posterior end of the body.

Another sipunculid worm is found in the sand near Pelican Island. It is much larger, more delicate in texture, translucent and light buffy in color, and attains a length of about eight inches.

Many tube dwelling worms were found, including several serpulids, many of which shed their own crown of tentacles quite readily in the watch-glasses in which they were killed. *Echiurus* was also found here with a long prostomium and without gills. Owing to Miss Mullin's industry, a very large collection of worms was preserved, which will well repay special study on the part of some competent helminthologist. Polychæte annelids furnished the largest and most conspicuous forms, doubtless including a number of interesting species.

Cœlenterata.—As would be expected in tropical waters abounding in coral reefs, we found an amazing array of cœlenterates, particularly Actinozoa. There were acres of branched *Porites*, covering the bottom at two or three fathoms like a carpet, their short rounded branches crowded thickly over the whole surface. Looked at through the water-glass, they appeared to be the exclusive occupants of large areas. But the recesses between the thickly clustered upright branches were peopled by various crabs, serpent-stars, and other common reef inhabitants; while small fishes cruised about under their shade.

In certain places off Hastings in somewhat deeper water, there were acres of bottom crowded with immense fronds of *Isopora palmata*, tan brown in color, with white edgings. These were in the form of great rosettes, sometimes ten or twelve feet in diameter.

Orbicella was also abundant, sometimes in the form of rounded heads, sometimes in clumps of club-shaped branches with ends as large as one's fist. I have never seen this form of *Orbicella* before, and we secured at least one fine specimen for exhibition purposes. "Brain corals" were also common, both on the shallows and on the reefs. Being more solid and massive than most of the other corals, they take an important part in reef-building, constituting a considerable portion of the coral rock of which Barbados is largely built. The common *Iso-*

pora cervicornis was not so abundant, but by no means rare, sometimes growing in quite shallow water. It is yellowish tan brown in color, the terminal calyces or madrepores of each branch being white. One species of *Isopora* with turgid branch terminations was called the "Corn flower" by Albert, our diver. A very fine, profusely branched species was new to me. It grew in great closely aggregated clumps of fine branches, resembling *Oculina varicosa*; but showing little cœnenchyma between the corallites. A large colony of this species makes one of the handsomest cabinet specimens in our collection.

It may be mentioned here that on account of the large supply of the more showy reef corals secured by the Bahama expedition twenty-five years ago, and also on account of their weight and the difficulty of transportation, we did not bring home so many fine cabinet specimens as on the former expedition; contenting ourselves with the forms new to us and a very few particularly fine specimens of the commoner species.

Among the smaller form *Siderastræa* was common, and also several forms of *Oculina*. *Manicina* was not so common here as at Antigua. One of the best forms for class use in the study of corals is *Eusmilia fastigiata*, found in abundance at Barbados. It consists of clumps of large corallites arising from a common base and forming a rounded head composed of these closely aggregated, but distinctly separated, corallites; many of which are an inch or more in diameter at their distal ends. When dried and cleaned they are exquisitely white and look like clusters of flowers carved in purest marble. The corallites being well separated and neither contingent nor confluent, nor so small as to require magnification for satisfactory inspection, this form is ideal for an introductory study of corals, a desideratum not easily attained. Our specimens were secured almost exclusively by diving, being found usually at a depth of three to six or eight fathoms. As soon as Albert found that this species was a welcome addition to our series, he would go out with one or two boatmen in the rowboat and secure as many specimens as we desired. Here again was demonstrated the great utility of employing divers on such an expedition as ours. Indeed we owe much to the faithful Albert, who seemed as keen a collector as

any of us. A little appreciation on our part proved a wonderful incentive to him, as it does to most of us.

And it was surely a delight to see him dive. I will not forget one occasion when we were collecting in this way near the reefs off Hastings. The boat drifts slowly over the marvellously clear water. Looking down through the water-glass we see the fronds of plumose alcyonaria waving gently in the lazy undulations of the sea, or bent gracefully by the current, looking like fields of pampas grass in a breeze. In the intervals between these the great rosettes of *Isopora palmata* lie motionless, interspersed with heads of brain coral; while the smaller clumps of *Eusmilia* look like daisies starring the bottom. Great "hat sponges" and many others of brighter hues almost pave the bottom here and there, while groups of gorgeously colored tropical fishes glide gracefully among the groves of gorgonians. A world of silent beauty, bathed in a crystal clear atmosphere of water! We see an apparently new colony of alcyonarian coral and point it out to our diver. Grappling hook in hand, he stands for an instant like a bronze statue of the perfect physical man, the massive muscles of his chest, back and arms bulging and rippling beneath a smooth brown skin, his intent rugged face set with determination,—a sight that would delight a master sculptor!

A clean dive and he disappears. We bend over the water-glass and follow his descent as he swims downward with easy powerful strokes of his long arms and legs. The water does not appear deep, so clear is it; but down, down he goes, the white soles of his feet standing out in sharp relief. Smaller and smaller he seems, diminishing in size until but a pigmy man is outlined against the white coral bottom. He is in fact some sixty feet beneath us. He swims head downward and hovers over the fronded alcyonarian, grasps it, fastens his short, two-pronged hook and tugs desperately to loosen its stubborn hold on a coral head. Suddenly it breaks loose and he swims upward, increasing rapidly in size until his round black head breaks the surface and he tugs the specimen, man high, to the boat. We carefully lift it in while Albert raises himself easily over the side and sits panting on the gunwale. The alcyonarian, so graceful and clear-cut while in the water is but a

slimy mass of matted branches now, covered with a wriggling, twisting host of serpent-stars; while from the crevices of its lobed roots scuttle numerous little crabs, and worms crawl from their refuge. Our collecting tubs are soon filled and the bottom covered with the litter of smashed coral heads from which we have gleaned a rich harvest.

The boatmen with long clean strokes bend to their task, as we glide over the swell homeward bound across Carlisle Bay with its camouflaged ships and gleaming white sails of local craft, along the shore of our island home and into the little cove just as a loud blast of the conch announces the welcome lunch awaiting us on shore. I know of no more delightful collecting than this.

Among the smaller species of corals were *Colpophyllia* with large tubular calyces agglomerated together, their walls being coherent throughout; *Favia*, small rounded heads with shallow polygonal calyces without evident cœnenchyma; several species of *Porites* and *Siderastræa*, and a *Mussa*. There were three species of *Agaricia*: the common *Agaricia agaricites*, *A. fragilis*, dredged at Station 71, depth 60 to 70 fathoms, and another species that will be described later. One specimen of *A. fragilis* is the finest that I have ever seen, being in the form of a large thin plate almost flat, fifteen inches wide and one foot high; the surface marked by rugose ridges or transverse corrugations which are wavy, often interrupted, and sometimes branched. Along the upper edges of these corrugations, close to the general surface of the corallum, the pocket-like corallites are seen in close set rows. From their centers radiate the delicate septa, which are continued downward over the rugosities and intervening cœnenchyma, forming fine lines or sharp ridges running vertically, and as nicely spaced as if ruled. These ridges are of two orders, higher and lower, alternating with each other. This extremely fragile specimen reached home somewhat damaged, but easily repaired, as the broken edges matched perfectly. When fresh the specimen was a pure light gray color.

Another *Agaricia*, secured at Station 96 over what is known by the fishermen as "Shoal Bank" at a depth of about 30 fathoms, is new to me, as I have never seen any description or figure at all like it. It grows in clumps resembling head lettuce, be-

ing made up of exceedingly thin almost papery leaves which are lobate and frilled at the edges; the most fragile and delicate foliaceous coral that I have ever seen. One perfect colony came through intact and is before me as I write. Originally it was a delicate light gray with a faint reddish flush suggesting a very light lilac, lightening to almost white at the frilled edges. The upper surfaces of the broadly lobed leaves contain the small corallites which are in little pockets or rather bracket-like pouches facing upward. They do not occur in regular linear arrangement as in other species of *Agaricia*, but are scattered in groups some distance from the frilled edges of the leaves.

This is probably the most interesting and most beautiful coral secured by us at Barbados, and the specimen referred to will have a place in the Invertebrate Hall of our museum.

The fauna of Shoal Bank seems quite different from that of the other localities where we dredged. It was evidently particularly well adapted to the *Agaricia* just described, many fragments of the delicate foliaceous colonies coming up in the dredge, but the fragility is so extreme that only a single perfect specimen was secured. The ground was also rich in comatulids, several species being found that we did not encounter elsewhere, as well as strange ophiurians, sponges, etc. Unfortunately, we got into difficulty in the choppy sea and tide-rips over this submarine ridge and were in serious danger of a disaster owing to the dredge catching on the bottom and the sudden strain ripping things up generally. It being near the end of our stay at Barbados, we were unable to revisit this ground.

Three species of *Orbicella* were secured, *O. annularis*, *O. cavernosa*, and another species not yet identified. *Oculina verrucosa* and *O. dispersa* were also found, the latter at Station 36.

A species superficially resembling *O. dispersa* is represented by a very handsome colony in the form of a dense clump of slender branches nine and one-half inches in diameter and six inches high. There are hundreds of these branches closely aggregated so that their tips form a rounded head. They are very slender and fragile, forked at the ends, the terminal branches being club-shaped. The corallites are usually less than two mm. in diameter, closely appressed together near the ends of the

branches where there is no intervening cœnenchyma. Lower down on the branches the calyces are counter-sunk in the general surface with evident cœnenchyma between. The septa are usually ten in number, a most uncommon feature in recent corals. Occasionally there are only eight, and in one case twelve were counted. Nine out of ten, however, have the ten septa, and that number seems characteristic of the species.

The most marked difference between this form and any of the *Oculinidæ*, however, is its spongy and porous structure and noticeably light weight, wholly unlike the unusually dense and solid structure of any branching *Oculina* that I have seen. In this respect it resembles most clearly certain species of *Pocillopora* from the Pacific; but from these it differs in still more important respects. Another fine specimen is allied to *Meandrina*. It is a cylindrical colony about nine inches high and four inches in diameter and has a regularly rounded top. The surface is covered with a very intricate labyrinth of confluent calyces, much as in *Meandrina sinuosa*, but the furrows are very much narrower, giving the appearance of vermiculation. This species is doubtless well-known, but although I have seen specimens in the hands of curio dealers, I have never seen one with a label showing the name. Miss Van Wagenen tells me that there is one in the National Museum, but here again the label seems missing. It is uncommonly beautiful form, reminding one of the carved marble pillars bearing busts and found in the central court of some of the houses at Pompeii.

The red coral, which is often brought up from deep water by fishermen, much resembles the figure of *Amphihelia rostrata* given by Agassiz in his "Three Cruises of the Blake," vol. II, page 152. It is a very beautiful coral, red instead of white, and the branches and calyces are much more delicate than in the figure. It sometimes forms colonies nearly a foot in height. Quite a number of simple corals were secured by dredging. They are all, however, small and inconspicuous forms and offer little of general interest.

Actinians.—The anemones, or "animal-flowers" as they are called at Barbados, were quite abundant in shallow water near Pelican Island. Miss Van Wagenen had charge of this group and has placed her notes at my disposal. Owing to her care,

the collection was preserved in exceptionally fine condition and is in much better shape than is ordinarily the case. But no known method will preserve the beautiful colors and delicacy of these exquisite forms of life. An excellent method of collecting was to take a water-glass and wade out breast deep in the shallows near the laboratory and with a dip-net or the hands secure the specimens that clung to the stones or were imbedded in the sand. These stones were most of them loose and not too large to handle, and thus the anemones could be brought, together with their support, to the laboratory for study and observation.

Probably the most conspicuous species secured here was a *Discosoma*, which was commonly attached to these stones. The disk is about eight inches in diameter, the tentacles very numerous and knoblike and in many rows on the disk. They are translucent brown with a greenish cast, growing in clusters of three to five. This is the species that, as mentioned before, was seen to capture small crabs. These crustaceans have their habitat under the disks of the anemones, but outside of the columnar body wall. If they happened to touch the tentacles, however, they adhered to their sticky surface and were transferred to the mouth. These crabs were taken into the stomach of their captors, the nutritive portions digested and the chitinous hard parts ejected again from the mouth. Another large actinian lived on the sandy bottom, not attached to stones. When disturbed it would withdraw into the sand, and when retracted its tentacles so closely matched the sand in color as to be practically invisible. The tentacles were thrown into curious contortions, twists and folds when retracted, so that they had the appearance of being branched. There were more than two hundred tentacles in a specimen of the average size. The color of this anemone was a "battle-ship" gray with the tentacles and verrucæ silver gray, the disk with three or four concentric zones of alternating light yellowish gray and dark gray. The disk of a fairly large specimen was six and one-half cm. in diameter. On June 7th, the larvæ were given off, some of which had reached the gastrula stage, while others had advanced still further and had attained some of their primary tentacles.

Other anemones were borne on the shells of mollusks inhabited by hermit crabs. They are one and one-half to two inches in

diameter with numerous tentacles in three or four series or whorls. The body is columnar in shape with two rows of reddish brown eyespots around the base. The general color is reddish orange.

But the most interesting actinian collected by us was entirely different from anything we had ever seen figured or described. It invariably lived as a symbiont or commensal imbedded in coral or coral rock, usually in the bottom of a deep fissure or cavity far from the surface. This strange creature sometimes attains a total spread of as much as four centimeters, although it would shrink to almost nothing when retracted.

There was an outer set of six very stout clavate tentacles, utterly different from any I had ever seen before. They were usually more or less rigid in posture, but capable of considerable flexion or retraction, sometimes appearing simply club-shaped, like an Indian club, and then a swelling would appear near the base of the head of the club and grow larger and larger until the characteristic forked or clavate head would appear. These tentacles were dark brown in color, abruptly capped by a purple termination consisting largely of nematocyst batteries. One of them measured 1.8 centimeters in length. These structures have doubtless some peculiar function, but we were unable to discover it, although histologically some of the cells look like gland cells. We did not notice, however, that they were particularly adhesive.

Inside of the circle of these large tentacles and implanted on the oral surface of the disk were a large number of translucent lanceolate tentacles, very delicate and sensitive, often drawn out to a fine point at the end, and usually in more active movement than the clavate tentacles. The oral disk was quite translucent, as was the short brownish columnar base. The diameter of the body was about two centimeters.

This species seems hardy and lived well in the laboratory for several days. Excellent photographs were secured by Mr. Ricker showing them in various positions and stages of expansion and retraction. One set of tentacles would at times be fully expanded, while the others were retracted. While under observation this species was seen to give off planulae which were secured and preserved. Taken all in all, this is one of the

strangest of the animals found at Barbados and we secured a good series of them which awaits investigation by whoever makes report on the Actinians.

A beautiful anemone was found growing on the rocks exposed to the full sweep of the heavy surf at Bathsheba on the north coast. It was deep maroon in color with the tips of the tentacles and verrucæ moss-green in very effective contrast. The disk was four centimeters in diameter, the body three-fourths of a centimeter high, and the tentacles one and one-half centimeters long. Several social anemones, probably belonging to the genera *Protopolythoa* and *Polythoa* were found exposed to the surf on the Bathsheba coast, where they fairly encrusted the rocks in places.

We were much amused on one occasion when our diver, Albert, was sent down to get a large expanded anemone at a depth of about six fathoms. He attempted it readily enough, but when it apparently vanished at the approach of his hand he was thoroughly frightened at such an uncanny performance and steadfastly refused to have anything to do with the spook-like creature after that. He was unusually fearless in facing the ordinary perils of the deep, but collapsed entirely when confronted by the unexpected conduct of a perfectly harmless anemone.

Alcyonarians.—One of the most notable features of the alcyonarian fauna of Barbados is the apparent scarcity of Pennatulaceæ or "sea-pens." A large portion of the Alcyonaria dredged from the Pacific consists of these beautiful and interesting forms, while from one hundred hauls at Barbados but a single pennatulid was secured and that was at Station 50, depth 33 fathoms. It appears to be a *Kophobelemnion*, about five and one-half centimeters long, white or rather translucent, with a greatly inflated rachis and scattered polyps with hardly any visible calyces, although the polyps themselves are large with very long tentacles. It is shaped like an Indian club and differs considerably from any form that I have seen. It may represent a new genus.

Several species of Gorgonellidæ were secured, a family not usually found in the western Atlantic. The most interesting of these is the species before referred to as having commensal

sphiurians matching it so exactly in color. It probably belongs to the genus *Gorgonella*. The colony is flabellate in form with the branches occasionally anastomosing, and some specimens attain a height of about eighteen inches. It was the commonest gorgonian found in our dredging, being secured at various stations. It is also the most beautiful alcyonarian secured by us, being a brilliant coral red with light yellow calyces that appear almost white against the red background. The calyces are usually biserially arranged, alternating along the antero-lateral edges of the branches, their walls being formed largely of rows of perpendicular spicules which also encrust the dorsal surfaces of the infolded tentacles. The cortex spicules of the stem and branches are bright red and in the form of girdled spindles characteristic of the family Gorgonellidæ. The axis cylinder is ivory white, smooth and calcareous throughout.

Three other species belonging to this same family are allied to the genus *Juncella*. They are unbranched rod-like colonies, showing a longitudinal band devoid of polyps. The first of these was from Station 55, depth 33 fathoms. The calyces are club-shaped, facing upward with their sides pressed to the stem and their walls armed with a mosaic of red spicules which also encrust the dorsal surface of the infolded tentacles. The spicules are the double clubs and double stars characteristic of the genus. Another species from Station 78, depth 35 to 75 fathoms, had much larger calyces, but was also deep red in color; and still another from the same station had very prominent calyces which were cylindrical in shape and very much more prominent than in any of the other species.

A very fine primnoid was dredged at Station 46, depth 100 fathoms. Two large flabellate specimens came up, appearing to be parts of the same colony. If so, the whole colony would be about seventeen inches high. It belongs to the genus *Primnoa* in the original sense, but would now most likely find a place in the genus *Caligorgia*. The calyces are in the form of bent clubs facing upward and inward and with walls beset with regular rows of scale-like ctenate spicules in imbricating series. The polyps are in whorls of four and the specimen bears a general resemblance to *Primnoa pourtalesii*.

Among the shallow-water forms of gorgonians, by far the

most conspicuous and graceful is *Gorgonia acerosa* which is a huge plume-like form, sometimes attaining a height of eight or ten feet. It consists of a main stem with many slender and very flexible branches arranged in a pinnate manner. Certain areas of bottom at a depth of three to ten fathoms are almost covered with these large graceful plumes waving in the current. They are pinkish purple in life, but the dried specimens are light buffy, sometimes almost white. The very widely distributed *Plexaurella dichotoma* is abundant here as elsewhere in the West Indies. It has large round branches holding themselves erect and rigid like candelabra. The calyces are inserted and in dried specimens are represented by round or slit-like holes scattered over the entire surface of the coenenchyma, which is thick and cork-like around the axis cylinder.

Of course the ubiquitous "sea-fan" is found here and is a favorite specimen with most tourists. It is the *Rhipidogorgia flabellum* of authors, and is really a very beautiful object with its fan-shaped reticulations of branches. The specimens from Barbados are mostly purple in color, the yellow variety being absent or at least rare. I am inclined to believe that the purple and yellow forms represent different species. A large number of species of the ordinary reef forms of gorgonians were collected here, but need not be enumerated. One, however, should be mentioned, as it appears to be new. It is a *Briareum*, having an axis cylinder composed of an agglutination of spicules. It differs, however, from the common *B. asbestinum* of the Bahamas in having the branches much more slender than in that species and is also a deeper purple in color.

The family Alcyonidæ seems to be unrepresented in our collection from Barbados, but the closely allied Nephthyidæ is represented by the genera *Dendronephthya* and *Spongodes*. At Station 49, depth 80 fathoms, was secured a colony of *Acanthogorgia*, or at least a portion eleven centimeters high. The branches and calyces are alternating; the latter being distant, columnar in form, standing out stiffly from the branch. The calyx walls are heavily armed with large spindle-shaped spicules arranged *en chevron* and terminating in a bristling mass of thorny points above the operculum. A species of this genus was described by Professor Verrill from specimens secured off

Barbados and may be the one just mentioned. Other species occur in the East Indies, while two are reported from Patagonia. An interesting find is a species of *Versluysia*, a genus instituted by the writer to accommodate certain forms collected in the Dutch East Indies by the famous "Siboga" expedition, which secured a magnificent series of gorgonians upon which it was the privilege of the writer to report. The genus is characterized by having a superficial layer of enormous spindle-shaped spicules placed lengthwise on the stem and branches, where they are not always in contact, revealing another layer of smaller and more slender spicules beneath. The spicules of the calyces are not arranged *en chevron*. A specimen secured by us measures nine centimeters in height and represents but a portion of the colony. It is sparingly branched, dark brown in color but rendered silvery by the frosting of the very large spicules by which it is covered. The outer layer is composed of comparatively enormous spicules, some as much as five millimeters in length. They are laid lengthwise on the stem and branches and curved to fit the surface and accommodate themselves to the contour of the calyx bases around which they bend. They look as though they were simply stuck on the branches, which they do not cover, leaving spaces through which the underlying spicules can be seen. The calyces are low, conical, or dome-shaped.

This is, I believe, the first record of the occurrence of *Versluysia* in the Atlantic, the other members of the genus being reported from Ceylon or the East Indies. The genus is named in honor of my friend, the distinguished Dutch naturalist, Dr. Versluys, a member of the Siboga expedition, which secured the largest number of Muriceidæ (96 species) that has ever resulted from a single expedition, more than three times as many as were taken by the justly famous Challenger expedition.

A representative of the beautiful genus *Chrysogorgia* was taken at Station 8, depth 80 fathoms. The calyces are all on the upper sides of the branches, the latter being geniculate and covered by a very thin cœnenchyma. The axis cylinder of this genus is noted for its brilliant metallic iridescence.

A specimen secured at Station 51, depth about 33 fathoms, is

more than ordinarily puzzling to the systematist, as it offers several points of intergradation between the families Muriceidæ and Primnoidæ. It bears so great a general resemblance to the latter that I at once placed it in that family. The color is a light buffy yellow so characteristic of the primnoids. The calyces are arranged exactly as in certain genera of that family and are in the shape of bent clubs facing the stem, a condition which, so far as I know, has never been found in the Muriceidæ. But when we come to examine this form in detail, characters essentially muriceid at once reveal themselves. For instance, the polyps are not protected by a real operculum, the most characteristic feature of the Primnoidæ; but the infolded tentacles have the dorsal surface encrusted with symmetrically arranged spicules, a very pronounced character of the Muriceidæ, and the spiculation of the stem is exactly that of the genus *Versluysia* discussed above. There is the same outer layer of very large spindles looking like a procession of worms crawling up the branch and bending slightly to accommodate themselves to the bases of the calyces. These do not form a solid layer, but are separated so as to expose processes of the underlying layer of smaller spicules. Moreover, while there is a crown of thorns around the calyx walls, a feature found in both families under discussion, these are the points of spindle-shaped spicules without a basal branched part such as are characteristic of certain muriceids; neither are the thorn-like projections from a scale-like base as in many primnoids, thus differing from both these families. Taking it all in all, this form really offers an intergradation between the Muriceidæ and Primnoidæ that is most interesting. Without wishing to commit himself definitely, the author provisionally regards it as a Murceid near the genus *Versluysia* which has adopted a camouflage very successfully mimicking a Primnoid; but it must be confessed that no advantage can be imagined to result from this imposture, and it looks like a perfectly gratuitous attempt to befuddle the hardly used systematist.

A representative of the remarkable genus *Placogorgia* was found at Station 19, depth 80 fathoms. It shows the peculiar disk-like spicules of this genus, the scales being round and looking like minute rosettes. Of the ten species of this genus thus

far described, but one is from the Atlantic, this one having been taken from St. Paul's Rock. All of the others were secured by the Siboga expedition in the Dutch East Indies. The writer is considerably impressed with the number of East Indian forms found among the Alecyonaria secured at Barbados, and wonders whether or not a study of the other groups collected by us will bear further evidence of the same thing.

Antipatharians.—One of the commonest species secured in our dredging off Barbados was *Antipathes columnaris*, which greatly resembles a small bottle-brush with stiff wavy branches thickly implanted on the sides of the straight central stem. It was colored a golden brown and came up with almost every dredge-haul. Many specimens showed hollow tubes lying along the main stems formed by an annelid which is commensal in this species. A similar relationship is found to exist between many deep-sea gorgonians and annelids. In some cases the worm apparently has the power of causing the spicules of the gorgonian to grow to enormous size, forming thin plates which are joined together so as to make a tunnel-like arcade running along the branches and furnishing a retreat within which the worm lives in relative security.

Another, and less conspicuous form, is *Antipathes spiralis*, which is in the form of a stiff wiry, loosely coiled, unbranched stem, forming a spring-like helix. Like all antipatharians, its axis cylinder is covered with small thorny points which may serve to prevent the very loosely attached cœenchyma and polyps from being stripped off. As it is, the stem is usually denuded before it reaches the surface in the ordinary course of dredging. This species was secured at a number of stations and at various depths.

Several species of other kinds of branching Antipatharians were secured. One from Station 75, depth 35 to 60 fathoms, was flabellate in form, fifteen centimeters high, very profusely and delicately branched. This and smaller forms of Antipatharians are often mistaken for hydroids; indeed the writer seldom receives collections of hydroids for identification that do not contain a few antipatharians. Certain species, again, resemble some of the Chrysogorgidæ so closely that the mistake is

perfectly natural. Collectors should keep in mind the fact that the stems and branches of antipatharians are always beset with minute thorny spines that can easily be seen with an ordinary hand lens. This character is seldom found in hydroids, and can be relied upon as a means of distinguishing between the two.

Hydromedusæ.—The pelagic fauna of this region seems very scant indeed, and not a single *Hydromedusa* was secured, nor did we find any of the *Scyphomedusæ*. On account of the rough water, we did no tow-net work, which may account in part for the apparent absence of jelly-fish.

Siphonophora.—This order is represented by the familiar "Portuguese man-of-war," and we were severely stung by the really formidable nematocysts from the innumerable batteries strung along the tentacles which hang beneath these beautiful but troublesome creatures.

Hydroids.—While a number of species were secured, they are by no means so numerous as in the waters around the western end of the West Indian chain. Very few of the gymnoblastic species were obtained, the only one that I remember being a species of *Pennaria*, which grows to a greater size than *P. tiarella* of our Atlantic coast. There was quite a number of calyptero-blastic species. One from Station 3, depth 75 to 80 fathoms, was a *Lafoea*, probably *L. gracillima*, having the gonosome or sexual parts in the forms of the *Coppinia* mass very beautifully shown. The whole structure is in the form of an ovoid mass of gonangia, intertwined with the delicate curved tubes so characteristic of the "*Coppinia* mass." Another beautiful form is a *Lictorella* closely allied to *L. halecioides* of Allman with its graceful tubular hydrothecæ with slightly out-curved apertures and borne on a slender pedestal. This was found at Station 21, depth 60 fathoms.

Several fine plumularians were secured, but none so striking as the handsome feather-like colonies which so delighted us during the Bahama expedition. A species of *Aglaophenia* new to me was taken at Station 3. It was dark brown in color and rather extensively branched. It bore a general resemblance to *A. ramosa*. In the absence of the gonosome it is not always easy to distinguish between *Aglaophenia* and *Lytocarpus*. Another

very interesting *Aglaophenia* is allied to *A. lophocarpa*. It has septal ridges in the hydrocladia; the corbula is an elegant structure, long and slender, with leaves free at their edges, and with long spur-like nematophores. The distal ends of the leaves are folded over the gonangia and bear several nematophores; but there are none on the edges of the leaves except near the ends, in which this species differs from any other that I have seen. It was taken at Station 51, depth 33 fathoms. Still another *Aglaophenia* seems to be *A. allmani*. *A. rigida* and *A. rhynchocarpa* were also secured.

A very fine specimen of *Halicornaria speciosa* is from Station 65, depth 50 fathoms. The hydrothecæ of this form are among the most graceful that I know of, the long curved mesial nematophore being the most prominent. The gonosome was present and consisted of top-shaped gonangia without a protective contrivance of any kind. *Lytocarpus* was represented by a single specimen from Station 21, depth 60 fathoms. Many of the hydrocladia were greatly elongated, with their distal portions devoid of hydrothecæ. This probably indicates that the species is capable of stoloniferous reproduction. But a single representative of the genus *Plumularia* was found. This was *P. megalocephala* and is from Station 65, depth 50 fathoms. The gonosome was present and resembled that of *P. setacea*.

Among the sertularian hydroids may be noted fine colonies of *Synthecium tubulifera*. The gracefully outcurved tubular hydrothecæ are among the largest found in the family and are transparent as the clearest glass. Another specimen was secured having the characteristic gonangia like minute Chinese lanterns growing from the lumen of the hydrotheca. There has been much controversy over the validity of this genus. It seems perfectly valid to the present writer, being well characterized by the unique feature of its gonosome.

The campanularians were represented in the main by various species of *Lafoeidae*. A beautiful *Lictorella* was found at Station 35, depth 80 to 90 fathoms. It had a distinctly geniculate stem and gracefully curved tubular hydrothecæ. Another, probably new, form has a fascicled stem and tubular hydrothecæ with a single annulation at their bases. *Cryptolaria* was represented by two species. One resembled *C. pulchella*, having

tubular hydrothecæ abruptly bent in the middle, the lower half being immersed in the perisiphonic stem. The type specimen is from near Havana. *Perisiphonia chazaliei* was found at Station 11, depth 67 to 70 fathoms. Several species of *Lafoea* were secured, and as usual they were mostly parasitic on other hydroids. *Campanularia marginata*, a very common West Indian form with unusually large, almost sessile hydrothecæ, was secured.

Of the hydrocorallines, *Millepora alcicornis* was as usual the commonest and most conspicuous. Its protean forms occur on most of the reefs throughout the West Indian region. We did not succeed in seeing the living zooids. Many delicate and beautiful species of deep water hydrocorallines were brought up in the dredge; but these have not yet been studied sufficiently for their identification.

Of sponges there were no end, but the writer has not sufficient temerity to attempt even an approximate identification in this group. One of the largest was abundant just outside of the reefs off Hastings. It was somewhat the shape of a cocked hat and was often three feet or more in length. The illustration shows the shape better than any description. The specimen photographed has a gorgonian growing on it. Another strange sponge is colored black and is about six feet long and four inches in diameter being almost perfectly round in section. Many calcareous and some silicious species were found in the dredged material. Their sharp needle-like spicules were an almost constant nuisance and kept our hands sore a good deal of the time.

Entomological notes. Mr. Dayton Stoner the entomologist of our party, has very kindly allowed me to use the notes that he has drawn up concerning his experiences while collecting, and some of the species which he secured. The facts are his, but the language is mainly the writer's.

The island of Barbados, being densely populated and having practically its whole area under cultivation, is not a particularly favorable place for collecting insects. In general it may be said that the insect fauna shows some affinities with that of South America as well as of North America. A few of our familiar species are found there as well as a number of indigenous forms.

The attitude of the natives, referring more particularly to the negroes, toward our collectors, was interesting. Mr. and Mrs. Stoner were constantly followed by a group of people who professed a desire to "help catch butterflies." The first question was usually "What are you catching?" and the second "What are you going to do with them? Make medicine?" The news of the advent of strangers in country districts was quickly passed around; rather mysteriously so, considering the lack of telephonic communication. While collecting in the Scotland District, the news was spread that the white man was a German spy, and Mr. Stoner was followed by a markedly hostile group who commenced to stone him. The children in particular taunted him, threw stones, and appearing suddenly in the most unexpected places through the various trails in that hilly district, made demonstrations which, although unpleasant, did no real harm. On one occasion, however, some husky natives appeared armed with a rope and announced their intention to capture our entomologist and take him to the lazeretto which was nearby, in order that he might be confined as a lunatic. They were evidently lacking in nerve, however, and Mr. Stoner proceeded on his way and is still at large.

The collecting places which yielded good results were in vegetation more or less protected along the terraces. Low weeds and grasses were worked by sweeping with the hand-net for plant feeding forms, where various Solanaceæ were favorite food plants for Hemiptera. The rank growths in the valleys and on the hills of the Scotland District, which in places is quite wild, were worked with good results; while many species of beetles lurked under rocks along the terraces. The vegetation bordering pools and along the infrequented streams was inhabited by other forms, as were the green borders of cane-fields, particularly where there was moisture. The cliffs and upland flats near Speightstown were found to be worth working, and the sandy beaches often afforded a chance to secure species not found elsewhere, Calais beach, in particular, being one of the best. This yielded several kinds of sand-flies and a fine white tiger-beetle.

There are several gentlemen in Barbados who take an interest, professionally or otherwise, in entomology. Among these

should be mentioned the Rev. N. B. Watson of St. Lucy's Parish, who has a collection and has long been interested, particularly in economic entomology; Mr. William Nowell, mycologist of the Imperial Department of Agriculture; Dr. J. C. Hutson, acting entomologist in the same department, who was taking the place of Dr. H. A. Ballou, absent in Africa where he was engaged in special economic investigations, and Sir Gilbert Carter, formerly Governor of Barbados, who has a fine collection of native Lepidoptera. All of these gentlemen rendered valuable assistance in the way of donation of specimens, helpful advice and hospitality.

Mr. J. R. Bovell of the local Department of Agriculture, should be specially mentioned in this connection, as he did much to further the work not only of the entomologist, but of other members of the party. The writer is, moreover, under great obligation to him for a delightful automobile ride to St. Lucy's Rectory where he enjoyed a no less delightful visit with the Reverend Mr. Watson.

Among the insects and their allies secured by Mr. and Mrs. Stoner, the following are worthy of notice:—

The Barbados tarantula was quite common in most places under the bark of decaying trees; and the centipedes were often found under stones and sticks where the ground was damp. They were three to six inches long, very active and hard to secure, requiring care and considerable dexterity to capture them without being bitten. A small species of millipede was common under stones, while a large black form with transverse bands of green was quite abundant. Mr. Stoner witnessed a migratory movement of this species from one canefield to another, in which one of the main highways of the island was crossed. The large short-horned locust (*Schistocerca pallens*) was abundant, but elusive, in the grass growing on the island. Mr. Stoner reports that it is one of the most difficult insects to secure that he has ever encountered. Its flight is rapid and it has a habit when closely pursued of crawling some distance in the short grass before taking flight again.

The *Pentatomidæ* (Mr. Stoner's particular pets) were found inland along the terraces where the vegetation is profuse. The "Pea chink" (*Edessa meditabunda*) was the most abundant.

It is green with brownish hemelytra. A trim yellowish-green species *Piezodorus guildingii* was also found. In all more than a dozen species of Pentatomids or "Stink bugs" were found.

On the rocky sides of the terraces were found many nests of the wasps called "Jack Spaniard" (*Polistes annularis*). With the exception of the ants there appear to be surprisingly few species of Hymenoptera, a large bluish-black carpenter bee being the most conspicuous. The order Lepidoptera was poorly represented, especially the butterflies. Two forms familiar in the United States were recognized. These were *Anosia plexippus* and *Pyrameis cardui*. Other species were *Catopsilia eubule* and *Dione vanilla*. Moths were moderately common and the larvæ and adult of the cutworm (*Prodenia*) were not uncommon.

A Scarabæid beetle (*Phytalus smithi*), locally known as the "brown hard-back" is a common pest which infests the sugar cane, the larvæ killing the plants by boring into the roots. Prizes are offered by the Colonial Entomologist of twopence per four hundred for these insects, in the hope of reducing their numbers. The "rose borer" (*Diaprepes abbreviatus*) is also a serious cane pest in certain parts of the island. This is a rather handsome striped weevil found throughout the West Indies. Our common spotted "lady-bird" beetle (*Megilla maculata*) and the red lady-bird (*Coccinella sanguinea*) are found, the latter being quite common. A large water beetle, *Hydrophilus* sp., and the smaller water beetles (Dytiscidæ) are rather common and the water-striders occur in considerable numbers. Several species of dragonflies and leaf-hoppers were noted in the vicinity of fresh water.

Scale insects were found in great variety, among which may be mentioned the white scale (*Chionaspis*), the purple scale (*Lepidosaphes*), and the black scale (*Saissetia*), a serious pest on cotton. Mosquitoes were remarkably few, except in the vicinity of ponds. One of these, however, a *Culex*, is guilty of transmitting the *Filaria* which causes the very unsightly deformity known as elephantiasis, some examples of which we saw. Fleas were abundant and very troublesome on Pelican Island. They seemed to be particularly fond of the scientists from Iowa.

The author can not refrain from mentioning, in connection with these entomological notes, the very efficient work done by

Mrs. Stoner. Day after day she accompanied her husband in the field, working in the hot sun or drenched by the frequent showers. It is just that she should share the credit for the excellent collection of insects obtained by the expedition.

Geological notes. Prof. A. O. Thomas, official geologist of the expedition, has kindly handed me the following notes, which I give in his own words. Professor Thomas was one of the most energetic and tireless workers of our party. He was always at work, and secured, I am confident, as complete a collection of geological material as possible in the time at his disposal.

The Greater and Lesser Antilles form a long chain which represents the tops of highlands or mountain peaks. This land mass has connected North and South America during certain geological periods in the earth's history. Much of the plant and animal life of the islands is a relic of the more widely distributed life of the periods when the islands were more closely connected. A very slight diastrophic elevation now would connect some of the islands, for example Barbuda and Antigua.

Some of the West India islands have experienced more or less violent volcanic activity. St. Kitts has a ridge of volcanic peaks culminating in Mt. Misery. Martinique has an active volcano, Pelée; St. Vincent has Soufriere; and St. Lucia the famous Pitons.

Barbados is set off from the chain of the Lesser Antilles by about 70 or 80 miles. Once in early Tertiary it was a part of the mainland mentioned above and the oldest beds, exposed in the Scotland district, are made up of sandstones, conglomerates, and shales intermingled in places with thin beds of volcanic origin,—mainly volcanic ash. These beds of terrigenous origin represent active erosion and transportation by running water from some nearby land now far beneath the sea. After that event the region was let down to great depths and beds of oceanic ooze of foraminiferal and other origin were laid down over the basic sands and shales.

The beds of "Barbados Earth," as the foraminiferal strata are called, are famous both for the radiolaria and foraminifera

they contain. Some hundred pounds of this earth were collected at the type localities.

Above the Oceanic deposits are the later deposits of coralline limestones. It seems that when the uplift took place that brought the sea-bottom high enough for corals to thrive upon it only the patch representing the present Barbados was so favored. Subsequent slow elevations brought the now higher parts of the island above the water and gradually further and still further elevations made the island larger, higher, and are responsible for the terraced effects which are so apparent even to the casual observer.

The diastrophic disturbances connected with the elevations and subsidences greatly contorted and faulted the older rocks. Beds standing at all angles, even vertically, and folding, flexing, and faulting are beautifully shown in the Scotland District where the later coral cap has been removed by the everlasting attack of the weather; especially have the waves driven by the strong and steady trades from the northeast had an important part in sculpturing this coast since its elevation to the zone of wave action disputed their right of way.

Barbados is not only isolated but its shoreline is simple and featureless; there are no islands off-shore and few indentations which offer good harbor facilities. The highest point is Mt. Hillaby, 1104 ft., from which the land slopes seaward in gentle terraces. These terraces are well-marked along the south-east coast beyond South Point Light House. The present shore line here for a mile or two is a vertical (in places deeply undercut) cliff some forty to seventy feet high; back from the seaward edge of this cliff some one-eighth to one-fourth mile rises another steep cliff scarred by weathering agents and covered by struggling, windbeaten shrubbery. It is thirty to fifty feet high, has numerous sea-caves,—one of them used by the owner as a night corral for a large flock of sheep.

The coral limestone overlies six-sevenths of the island and is very porous, so much so that the greater part of the rainfall sinks immediately into the ground and finds its way to the sea in underground passages. For this reason there are no streams of any consequence on the coral limestone part of the island. Solution has dissolved out many and devious underground pas-

sages in the limestone, none of them long or large, except perhaps for one or two caves; Coles' cave on the Walkes Spring Estate is the largest and may be explored for some distance underground; The Manning cave is another example; human excavation is responsible for the greater part of the rock removal from this interesting cavern. Limestone sinks are not uncommon and these depressions are in some cases nearly filled with water during the wet season and a few of them never go quite dry.

The seaward edges of some of the higher terraces are deeply gashed by vertical box-like canyons a few hundred yards in length; a good example was seen in the vicinity of Mt. Brevitor on the Whitehall Estate. A sea cave on the slope of this hill at an elevation of 381 feet above the sea and 100 feet above the canyon-cut terrace at its foot is 75-100 feet in extent and 30-40 feet high inside. Other smaller caves are common along this bold scarp. The fauna and flora in them is of great interest. A maidenhair fern so delicate that the first touch of sunshine outside wilted it as if scorched and some pale whistling frogs and numerous land snails chiefly *Subulina octona* were the commonest.

The residual clay and marl formed from the decay of the coral limestone makes a very good soil and where it is fairly thick above the mantle rock it holds moisture well. The fact that this soil has been extensively cultivated for centuries, growing sugar-cane most of the time attests its fertility.

The roads of the islands are fairly good. Many automobiles make for their upkeep. Their dazzling whiteness is due to the use of the limestone into which, especially along the edges of the terraces, they are cut and with which they are constantly mended.

The coral limestone is quarried by hand in the most primitive way, being cut with simple tools into blocks of various sizes, the commonest size is $1\frac{1}{2} \times 1 \times 2$ feet. Many of the finest buildings in Bridgetown are constructed of the local stone and it makes rather pleasant appearing structures and is quite durable as it seems to harden upon exposure to the weather; the Public Buildings, the Cable Office, Sir Gilbert Carter's home, etc. are some examples. There are many fairly good sized quarries in

and about Bridgetown; one on the Pine Estate; the one operated by Mr. Charles Knight; one on Ex-Governor Carter's place, and one at which the convict labor is employed may be mentioned.

Much of the local limestone is suitable for limeburning and a considerable amount of this product is made for home use. A small amount is exported; the scarcity of fuel limits the production. A considerable quantity of the stone is used for marl upon weak soils; nearly every plantation has its marl pit.

One of the most fertile parts of the island is St. George's valley which extends west of Bridgetown toward the Crane. It lies between the low Christchurch hills and the highlands of the parish of St. John. The Barbados National Railway follows this valley and some idea of its fertility and rolling topography may be obtained as one rides along from Bridgetown to Carrington and beyond.

The southwestern part of the island is the driest. Rainfall is much less here than on other parts of the island. The greatest rainfall is on the higher lands; every terrace differs from every other and one estate has a different record from another. In many cases these records have been assiduously kept for 50 to 75 years. It is surprising that there should be so much difference in so small an area as 166 square miles; but it goes to show how slight topographic differences such as change in elevation, etc. modify the elements of climate.

Additional notes on the Scotland District:

Chalky Mountain is a mountain in miniature; the color effects of various strata of sands are pretty and the rough appearance and actual conditions of the surface due to differential weathering are very interesting.

The soil of this district is dark and sandy due, of course, to the fact that the underlying rock is not coral limestone but sandy shale and harder insoluble rock. Here the rainfall does not penetrate the ground, and water stands in small pools and depressions until it evaporates or is used by man or beast for drink. A few small streams occur, the largest is José's River, a turbulent stream which has cut a sharp valley filled in the stream bed with large boulders. It has a fresh-water fauna, small fishes, crustaceans, etc. In times of heavy rain great

volumes of dirty water flow into the sea from the Scotland District; this largely prevents coral growth in the offshore waters. The absence of subterranean drainage makes this small district less healthful than the remainder of the island. Such diseases as typhoid and pellagra are not uncommon.

In the older rocks of the Scotland District is found some very high grade oil. It occurs under the low folds of the much distorted Tertiary rocks. The great number of faults and the small size of the folds preclude the occurrence of any large quantities of oil. Two or three wells produce a small amount of petroleum which has an asphaltic base and is not rich in the light oils. It is well suited for lubricants.

In this district occurs also a variety of bitumen known as "manjak" or glance pitch. This "Barbados tar," as it is known in England, early held an important place in *materia medica*. Its chief use is as a basis for black varnish or japan; its jet black color obviates the necessity of mixing with it any pigment.

Tarry sands occur in many places in the valley; at one point these have been burned and the brick-colored hill is called Burnt Hill.

The quantities of sand washed down to the beach in the district has been heaped into ridges along shore by the waves in places and the wind has made migrating dunes of it; these interfere with the outlet of one or more of the small streams between St. Andrew station and the sea, and a brackish water pond, called Long Pond, has resulted. The dunes are covered in places with a very interesting mass of vines, which tend to bind down the sand and prevent its migrating. Some of the vines noticed were forty to sixty feet long with occasional rootlets, serving as holdfasts, penetrating the sand. .

The writer accompanied by Willis Nutting approached the Scotland Valley from the west by walking overland from Speightstown. A little beyond Farley Hill they reached the edge of the concave escarpment which passes around the great amphitheater-like valley. This escarpment is in places so abrupt that it can be climbed only with difficulty; here and there the edge is incised with notches made by running water and along its border rise Hillaby, Chimborazo, Misery, and

other culminating eminences of the island. To the extreme left as we faced the sea stood Pico Teneriffe close to the Atlantic guarding the northern approach to the valley. To the extreme right the escarpment is still more rugged and frowns down from nearly 1000 feet upon the shore line less than a mile away. This part of the cliff is called Hackleton's Cliff. The abrupt declivities from the escarpment to the sea have given opportunity for running water to accomplish erosion on a scale much more gigantic than one would expect on so small and low an island. Landslides of tremendous proportions are not rare. In the farther flatter parts of the valley were little farmsteads, ribbon-like dark roads, the tiny railroad and its terminus at St. Andrew, while only two or three miles away was the white line of the surf beating away at the foot of Chalky Mount. This view, for one sitting in the delightful breeze, was one of the finest of the summer.

The island of Barbados is surrounded by coral reefs which encircle it except on the windward side; these reefs extend in some cases to three miles seaward. The fact that very little sediment is carried into the sea from the land except opposite the Scotland District is in favor of coral growth. Pelican Island is made up of coral sand and before the artificial sea-wall was constructed it was scarcely above the level of the waves. At low tide it is an example of a land-tied island being connected with the mainland by a deposit built up by the waves and currents.

A representative series of fossils was made from the limestone exposures in and near Bridgetown. The best collections were made in a quarry on the Hawkins estate at about the 200 foot level above the sea; specimens were also obtained in the quarry operated by Mr. Charles Knight, north of Bridgetown and in the walls of the cutting along Industry Road; in fact, nearly every exposure, natural or artificial, about the level of these just mentioned yielded good fossils. The fossils are chiefly corals and molluscs with occasional representatives of the echini and crustaceans. Many of the forms collected are quite the same as those living near the shore of Barbados to-day. No special effort was made to secure a large collection of the corals, since the forms occurring have been exhaustively studied by Dr. Gregory of England; it is hoped that a representative of each species

described by him is among the corals obtained. A large and exhaustive collection of the molluscan fossils was made and it is quite certain that many new forms were collected, among them a very fine species of the genus *Oliva* retaining the color markings remarkably well. The commoner genera occurring here are; *Oliva*, *Cerithium*, *Astrarium*, *Conus*, *Livona*, *Cassis*, *Strombus*, *Voluta*, *Cancellaria*, and *Fissuridea* among the gastropods and *Lucina*, *Cardium*, *Spondylus*, *Pecten*, *Chama*, *Arca*, and *Venus* among the pelecypods. In the fine marl on the floor of Mr. Manning's cave was collected a large number of very minute forms which in Mr. Henderson's opinion are not heretofore reported from this part of the West Indies. There may be some new species among them.

The collections made were augmented by many fine specimens from the collections of Sir Gilbert Carter, of Mr. Samuel Manning, of Mr. Charles Knight, and of Mr. H. P. Bascom all of whom generously donated many highly prized specimens, and rendered much valuable aid. Rev. N. B. Watson of St. Lucy's Rectory also gave the writer many fine specimens not only of fossils but of marine and fresh water and land mollusca; he also loaned several valuable specimens of fossil sea-urchins for description and study. The latter gentleman's intimate knowledge of the natural history of Barbados was placed at the geologist's service and he was saved many hours if not days of his own time by being able to go without loss of time to the most favorable localities.

Mr. William Nowell of the Imperial Department of Agriculture also very greatly assisted in the prosecution of the work. He accompanied the geologist to the Scotland District and to Spencer's at Christchurch. On both occasions his familiarity with geological and other conditions was of inestimable value for the rapid survey of the places visited. Through his kindness nearly all of the classical localities at which infusorial earth and Globigerina marl may be found were visited and much of these rare earths and marls was collected. Indeed too much can not be said for the hearty coöperation and unbounded generosity of all the officials, colonial and imperial.

A report is being prepared by the geologist on some of the geological features of the island, and an illustrated report on

the fossil mollusca will also appear. Many requests for the latter were made at Bridgetown and it is believed that it will stimulate considerable interest among local naturalists and collectors.

CHAPTER VI

BARBADOS

Although the writer realizes the fatuity of a discussion of the physical, political and social conditions of a country based on a few weeks' visit, there was so much that interested us during our stay among the Barbadians that it would seem ungracious to pass this subject without presenting the impressions gleaned as a by-product of our more serious scientific work.

This island is perhaps as little known to the American public as any in the West Indies. There appear to be no American residents there except the United States consul and his family; although there is considerable commercial relation between the two countries, and several lines of steamers ply between them regularly even in war time. Normally, there are at least four lines of communication between Barbados and New York. Steamers leave both ends of the line at least one a week on the average. Bridgetown is a port of call for many vessels plying between North and South America and between Europe and South America.

Barbados is the easternmost of the great West Indian chain of islands, being actually over six hundred miles east of New York and in latitude 13 north. It is almost constantly swept by the trade-winds and is exceedingly healthy; and not too warm for comfort, except at times in the city of Bridgetown, where the glaring white streets and comparatively tall buildings result in a temperature which is at times somewhat trying, reaching about 88°, but we never found it really hot at night.

The island is rudely triangular in shape, being about twenty-one miles long by fourteen miles wide. The coast shows less indentation than any other that I have seen, and as a result of this there are no real harbors, Carlisle Bay near Bridgetown being merely an open roadstead, but offering a lee shore to the prevailing winds. The land is low and gently undulating for

the most part, but there is an exceedingly picturesque region called the Scotland District in the northern part which offers a landscape approaching the mountainous and is really very attractive. There are no rivers of any size, and the drainage is practically all inward, thus resulting in a number of springs and underground waters filtered through limestone and perfectly pure and sanitary. These waters have been tapped at Newcastle, Codrington College, and other places, and piped all over the island, an inestimable boon to the dense population.

Almost the entire area is under cultivation, the raising of sugar-cane being the preponderating industry; and the green fields of the sugar estates are in evidence almost everywhere, looking a good deal like cornfields in the distance. The wind-mills that dot the landscape are fast disappearing before the modern methods of grinding that are more efficient but much less picturesque. When one gets away from the low lying plains around Bridgetown with the predominant palm trees and other tropical vegetation, he is at once reminded of English landscapes and sees the reason for this island being called "Little England." Very few of the trees are the same, but the mahogany trees that line the roads look like northern trees. By the way, there is a great quantity of good mahogany lumber in the scores of heavy lighters that choke the "careenage" at Bridgetown. The mango tree with its dark green leaves and dense shade also has a sort of northern look.

The roads are excellent, for the most part smooth as city boulevards, with easy grades and kept in good repair; thus rendering all parts of the island readily accessible to the autoist. In places one sees long lines of Australian pines which look a little like Lombardy poplars in the distance and seem to serve as windbreaks.

Aside from sugar-cane, there seem to be no vegetable products raised in quantities sufficient to encourage exportation, although many are cultivated for the use of a local populace.

Material for building is abundant in the shape of coral rock which underlies most of the island, is easily quarried, and quite durable in a land perpetually free from frost. Many fine buildings attested its utility for architectural purposes. There is much talk of oil wells, but as yet none of importance have

been opened. A curious product known as "manjac" has been mined and exported to a limited extent. It is used in the manufacture of varnishes and paints and is found in the Scotland District.

But it is the population that interests us more than anything else, aside from our main zoological work. Here we have one of the oldest British colonies in the new world. It always has been British since its discovery in 1605, and it is British still to the very core, although the population is African, fully nine-tenths of it. This colony differs from all others, we are told, in having a constitution of its own and a legislature to make its own laws. As I understand it, the relation between Barbados and the mother country is much like that between Canada and England. The Governor and Executive Council are appointed by the crown, but the legislative body is elected by the people. There is, I believe, a property qualification for the right of suffrage. Two members are allowed from each of the eleven parishes, and additional ones from the city of Bridgetown. The Assembly is elected annually. Some of the high officials are negroes, and I heard of a chief justice of that race who seems to have served with unusual ability and to the satisfaction of both black and white citizens. There are two departments of agriculture, one Colonial, with Mr. John R. Bovell as its chief, the other the Imperial Department of Agriculture for the British West Indies with Sir Francis Watts as Commissioner. To the former we owe thanks for many courtesies, and to the latter more than we can well express, as will be understood by those who read this narrative.

We conceived a high regard for the police force, which seemed well trained and efficient and aided us on several occasions. They impress one as a soldierly, well disciplined lot of men; and are, so far as we saw, all negroes. The population of Barbados, according to the guide-book published in 1908, was at that time 196,000 or 1,180 to the square mile, the densest population in the New World. The island fairly swarms with blacks, and the struggle for existence must be exceedingly severe; but the result has not been entirely without recompense. There is not much idleness there, and every man and woman, and many of the children, have to work more strenuously than in the

other islands. It strikes a stranger that, in spite of this (possibly because of it), there is a good deal of contentment and little actual want.

Nearly all are poor according to our standards, but they have an air of self-reliance not usually encountered in the other islands. Many of them look one straight in the eye and there is little cringing to the white man. They have the reputation of being better workers than the people in the rest of the West Indies, and they have to be that to live.

It seems strange to see women at work repairing the streets of Bridgetown and on the plantations; but they look strong, are often buxom and full breasted. The universal habit of carrying things on their heads has made them straight, well balanced and graceful in their carriage. They bear not only heavy loads in this way, but even small things that with us would be carried in the hands. For instance, one often sees a woman carrying a bottle balanced on her head, but I never saw anything fall. One of these women would never think of carrying a bucket of water in any other way than on the head, and ordinarily the hands are not used to steady the load. Little children are often seen with full buckets on their heads much too heavy for them to lift into position. This is done by someone else and then they trot along quite contentedly. All of the women wear a turban or some kind of head-cloth, whether they are carrying anything or not. We hardly saw an uncovered head out of doors during our stay.

The people constantly talk and often seem to be quarreling, but we had difficulty in understanding them when conversing with each other. When they spoke to us, however, their language was well chosen and much better English than we ordinarily hear among the negroes of the southern states. Although wages are pitifully low according to our ideas, these people are seldom badly treated by the whites, so far as we could see. Indeed, we were given to understand that it is a serious offence to strike a black man and sure to be punished severely. This may account for their fearless demeanor. As before indicated, even the servants have servants; and they seem to be in a more unfortunate position than the servants of white people, for they can be and are whipped apparently *ad libitum*.

In dealing with them, the stranger is apt to be over-reached in various ways and comes to feel that he is regarded as entirely legitimate prey. Like our own negroes, they seem to think petty pilfering nothing to be ashamed of and entirely commendable so long as it is not discovered. For small offences they are sentenced by the magistrate to a whipping with the "tamarind rod," which is rather commonly administered. The newspaper often had an item to the effect that such and such a one had been sentenced to so many strokes of the tamarind rod. While whipping by a master is illegal and may be punished, whipping by law is the commonest penalty for petty offences. In some ways this may be preferable to imprisonment; as it does not deprive the bread-winner, and all of them are that, of his time and very necessary wages. Thus the court is not under the necessity, as is too often the case with us, of either making the family of the laborer suffer by the loss of his pay, or letting him off entirely.

I have little knowledge concerning the status of these people regarding sex morality. An interesting side light, however, was thrown on the situation by a naive remark of a prominent white business man, "My father had twenty children, *not counting the illegitimate ones.*" I suppose that as a matter of fact these natives, like those on the other islands, are not so much immoral as unmoral. The distinction is one that is by no means immaterial, and should be kept in mind by anyone discussing the matter.

Of course our party was a source of a great deal of comment among these people, and equally of course they had their own explanation for our unheard-of proceedings. As was to be expected at this time, we were under more or less suspicion and many firmly believed us to be Germans with intent to commit some atrocity characteristic of the much hated Hun. One man on the shore opposite Pelican Island spent a considerable portion of his valuable time watching our performances, especially when dredging, through a spy-glass. He probably found what he was looking for, as is usually the case. At any rate, his Excellency, Governor Fell, received an anonymous letter stating that the writer could positively prove that we were engaged in planting mines off the shores of Barbados, and that a terrible

catastrophe was shortly due! He also expressed his opinion of the Colonial authorities who were so blind as to allow these dangerous enemies to have quarters on Pelican Island; and the opinion thus expressed was, to say the least, far from complimentary.

The small destroyers that daily cruised along the coast sometimes came and looked us over while the launch was at work; but only hailed us once, and seemed satisfied when informed that we were part of the scientific party on Pelican Island. Occasionally not only the negroes, but white people of more than ordinary intelligence were far from convinced of the harmless nature of our proceedings. To be perfectly fair to them, it must be acknowledged that our daily habit of cruising in an erratic way a mile or two off shore and occasionally stopping to put over the dredge, which at that distance might well look like a mine to the watcher on the shore, would be a cause of concern to anyone unable to comprehend the facts that a party of nineteen people from far-away America should visit Barbados wholly in pursuit of knowledge of the animal life of those waters.

On one occasion it looked for a time as if our work would be seriously interfered with, and in a perfectly legitimate way. It seems that a transport was expected that brought with it a number of West Indian soldiers invalided home from Europe, and the military authorities had some intention of quartering about eighty of them on Pelican Island; which would have made our position far from pleasant, if not entirely impracticable on account of the women in our party. Mr. Sanderson, representing the Board of Health and personally in charge of the island, Captain Hutson of the Military Medical Staff, and Captain Hancock, called on us to look over the situation. We explained that we would regret more than anything else to stand in the slightest degree in the way of the comfort of the invalided soldiers and that we were ready at once to vacate Pelican Island, if it was needed for any military purpose whatever. The officers were entirely courteous and tactful, looked the ground over carefully, inspected our quarters and the laboratory, which was in full operation, and gave their decision on the spot. This was to the effect that they were "unwilling to

disturb the work of this scientific expedition and would find quarters for the men elsewhere." As a matter of fact, entirely satisfactory quarters for the war invalids were found on the mainland, and we were undisturbed. I mention this incident to show the real appreciation of the work of our expedition constantly evinced in the bearing of all the officials with whom we came in contact. To my mind there can be no surer criterion of enlightenment than the recognition of the values of scientific work, and I never saw it better illustrated than in the whole bearing of these gentlemen on this occasion.

It was interesting to note the effect of war conditions on this remote colony. As said before, there seemed to be nothing in the way of food restrictions, although a law had been passed forbidding the exportation of certain food products. This was doubtless rendered necessary by the dense population which needed all that could be raised on the island or that could be imported from the United States and elsewhere. Prices were high for Barbados, but low from the American standpoint. Meats in particular were seemingly abundant and the prices reasonable. No income tax had been imposed, although a measure had been introduced in the Assembly for that purpose and was being earnestly discussed. The opposition was somewhat bitter, according to the newspaper accounts.

The British West Indies had sent many men to the war and were thus doing their bit. The dominant white element had contributed numerous sons and brothers to the mother country, and almost every family with which we became acquainted was mourning the loss of one or more of its men. These losses were borne with characteristic British repression of emotion, and there was to me something admirable in the calmness with which the death of their dear ones was faced.

These colonies are maintaining British traditions on the great battle front. All appeared to appreciate fully the service that that United States was rendering, and were not slow in expressing their gratitude that our country had at last aligned itself with the Allies. At that time the outlook was gloomy indeed, the great German drive of the summer of 1918 being in full swing, but there was grim determination to see it through and no evidence of any doubt as to the final outcome.

As indicating the almost savage hatred for the Germans, the following incident is enlightening. We became acquainted with a certain Captain who had already lost a leg at the front and was serving at the local barracks. He was a fine fellow with a frank boyish face and winning smile, in spite of the suffering which still almost incapacitated him at times. One day just before we left, I met him in Bridgetown and he announced the arrival of a baby boy at his home. Then with an expression of almost tragic ferocity, he added, "Another man to kill the d——d Germans!" Nothing could more clearly show the legacy of hate which the outlaw nation has entailed upon itself than this incident.

The thing that impressed us most in our dealings with the Colonial authorities was the ease with which they dispatched their business with us. They had a way of going straight to the point without circumlocution. Having once assured themselves of the character of our expedition, they readily granted every concession that was suggested. Our own officials, although every whit as well disposed, seemed tied up in the red tape of innumerable regulations to such an extent that great delay and annoyance was inevitable. It may be that the fact that the British Colonial officials are men who have worked their way up in their profession, which is regarded as equal in dignity and permanent of tenure to the military profession, makes this difference. It seems that the Governors of the British Colonies, for instance, are men who have devoted their lives to this sort of work and know its scope and traditions. They have usually served in various parts of the world and had dealings with all sorts of people. In their contact with strangers they have a courtesy and poise which can only be the result of life-long habit.

Our financial dealings with the business men of Bridgetown were mainly in the matter of purchasing supplies for our commissary department. We found several really well-equipped general stores, or shops as they are called, where the stocks were ample and almost any ordinary commodities could be secured. These shops are equivalent to the department stores of moderately large cities in the United States. Money matters are rather puzzling to the stranger. Both the shilling, or in com-

mon parlance the "bob," and the dollar are recognized units of value. The five-dollar note or greenback is current, but much larger and more cumbersome than ours, and the pound note is still more formidable. Both cents and pennies are used in quotations, but the former is really a "hapenny" and threepence and six-penny coins are in circulation. The crown, sovereign, florin, and guinea are also on hand to bewilder and confuse the stranger. We may be prejudiced, but it certainly seems to us that an honest, straightforward decimal system has very material advantage over the multifarious monetary denominations of our friends the British. We found, moreover, that in the matter of exchange, we were caught "coming and going," having to face a discount in any event.

Socially, we were the recipients of the proverbial Colonial hospitality at its best. This usually took the form of afternoon receptions and four o'clock tea. This time honored British custom is as prominent here as in England itself. Along with the tea were served various kinds of delicious cakes and confections, together with the local concoction known as the "swizzle." This is in fact a kind of a cocktail mixed by the use of the "swizzle-stick," a household implement unknown, so far as I am aware, outside of the West Indies; although I remember encountering a similar contraption in South America used in mixing a soft drink composed of cocoa, parched corn and sugar and called "tsetse." The swizzle stick is composed of a reed-like axis from one end of which project a number of slender branches at right angles to the main shaft. This affair is twirled between the palms of the hands and acts somewhat as an egg-beater, raising a foam on the surface of the swizzle. Being from a prohibition state, I did not seek out the formula by which this Barbadian specialty is made. Indeed, it may be a State secret to which only a favored few are admitted. Some friends informed me that it had considerable "kick," but there were no visible results, so far as I could see.

These afternoon receptions and teas are entirely informal, and here one meets most of the more prominent members of Barbadian society and finds it much the same as would be encountered in England or under similar circumstances in the United States. Cultivated people are much alike the world

over, and always worth meeting. One of the first invitations we received was to an "at home" from Governor and Lady Probyn. One the afternoon designated we took carriages and proceeded to Government House where the military guards saluted as we passed and an attendant received us at the door. The "at home" was held in the beautiful park-like grounds of Government House, where his Excellency and Lady Probyn received their guests informally and sent them with an attendant to the pavilion where tea and other refreshments were served. Tennis was the order of the day and the excellent courts were surrounded by seats for the convenience of guests, and a military band performed very creditably. Here were congregated most of the élite of the colony, who watched the game or strolled about the grounds at will. We met a number of delightful people and found ourselves at once welcomed into Barbadian society.

Governor Probyn was appointed soon after this to a new post at Jamaica, and our friend Colonial Secretary Fell was made acting Governor until the new incumbent, who was then somewhere on the other side of the world, should arrive at Barbados. We were entertained on several occasions by Governor Fell, and he did everything that the most friendly interest could devise to make the stay of our party on Pelican Island pleasant and profitable. This attitude was of course a most fortunate one for us and we were made to feel ourselves among friends from the very start. Sir Frederick Clark called very soon after our arrival and we met him on several occasions. He was very much interested in our investigations concerning the white "sea egg."

Another home whose hospitality we much enjoyed was that of Sir Gilbert and Lady Carter. Their residence "Harocourt" was one of the most imposing that we saw, and was constructed after plans drawn up by Lady Carter, who is an American woman, by the way. She even executed some of the carvings in stone, which are greatly admired. Sir Gilbert has served in various parts of the world and has been Governor of the Bahamas and later of Barbados. We were particularly interested in numerous objects which he had brought from Africa, such as weapons and carvings in wood, and it was here that we first

saw a good exhibition of skill in the ancient sport of archery. Sir Gilbert and the Governor were the main contestants, and although the former is over seventy years old, he seemed to hold the championship.

We were also delightfully entertained at the home of Sir Francis and Lady Watts. Sir Francis was absent on official business in the Bahama Islands at the time, but Lady Watts was most friendly and introduced us to many prominent people at her home and furthered our interests in various ways. Mr. Samuel Manning and Mrs. Manning invited our whole party to visit their estate and inspect the coral cave which had recently been discovered on their land. Their residence is one of the most sumptuous that we found and contained a surprising number of objects of interest to connoisseurs of art. This conservatory and aviary were among the best that I have seen anywhere.

A coral cave had been discovered just before my visit of the preceding summer, at which time I had the pleasure of inspecting it. While blasting rock in the process of levelling a portion of his ground, Mr. Manning uncovered a subterranean cavern which had been formed evidently by the action of an underground stream cutting through the coral reef that had been elevated, along with practically the whole Barbados, until now it is considerably above the level of Bridgetown. Mr. Manning had already taken out some hundreds of tons, I should judge, of almost pure coral, and intends to turn it into lime for commercial purposes. As coral is nearly all limestone, this has proved of considerable value. The cave has been enlarged by the removal of this coral and presents a most novel and beautiful spectacle.

We entered by a series of steps cut in the coral rock and leading to the floor of the cavern, which is approximately 25 feet high, 30 feet wide, and 100 feet long. The walls and ceiling are formed entirely by exquisite white coral heads and branches, the latter looking much like trees after one of our northern sleet and snow storms. The tracery of these beautiful branches revealed by the light let in from above and aided by electric lights in the cave itself was wonderfully beautiful and seemed like the realization of an Arabian Nights Dream. Nothing that we saw

during our trip was more enchanting than this and no scene will linger longer in our memory.

The various species of coral found in this cave are as perfectly preserved as those found in the reefs around Pelican Island today; and nearly all of them are the same species, proving that the formation is quite recent from a geological point of view. Mr. Manning has a large collection of corals, mollusks, etc. taken from this cave. Some of the latter were of great interest to Mr. Henderson, our "shell shark," and Professor Thomas, our geologist. Through Mr. Manning's generosity a number of specimens were added to our collection.

Mr. Bovell, chief of the Colonial Department of Agriculture, took some of us on a delightful auto ride to visit the Reverend Dr. Watson, Rector of St. Lucy's church, at the extreme northern end of Barbados. This ride was in itself a rare treat, showing us a part of the island that we had not seen before. Much of the way the road ran along the coast, through groves of cocoanut palms and other picturesque trees, and between fine suburban estates. Later we were passing through the sugar plantations with the long rustling leaves of the cane on either side. Here and there wind-mills with their revolving arms, stood out on the horizon. Later we were among hills, and the road wound along the course of quiet valleys with little villages at unexpected places, until St. Lucy's Church appeared, with its adjoining rectory.

Dr. Watson is perhaps the best known of local naturalists and I had heard of him frequently on my previous visit. He called at Pelican Island soon after we took up our quarters there, and is one of those rare spirits, a born naturalist with a devotion to living things of all sorts second only to his love for his parish and parishioners. He is an all-around naturalist of far more than ordinary ability, and his love for animals amounts to a passion. We were astonished at the size and excellent condition of the collection which he had gotten together during his residence, life-long, I believe, on the island, and the tender care with which he hovered over and handled his beloved specimens bespoke the old school naturalist of the best sort.

A considerable part of his collection had been sent to the British Museum for identification, and part he had succeeded

in identifying himself. All were neatly installed and labelled with painstaking care. I have met several scientists of this sort in various parts of the world, working without the inspiration of congenial confrères and adequate laboratory facilities; upheld by a whole-hearted devotion to nature and inspired with a zeal without limit. Such men I esteem and admire, and to them I offer the hand of fellowship. May their tribe increase! Dr. Watson has a large family and a limited income. His parochial cares are many and he serves his community with the same loving solicitude that he bestows on his collections. I was told that on one occasion when famine threatened his parishioners, he went without food himself that their necessities might be supplied.

His wife and the women of the neighborhood were busy preparing bandages for the army and were using a machine contrived by Dr. Watson himself for rolling them. We found the women here, as at home, devoting themselves to war work. There is an excellent Self-Help organization at Bridgetown, which we were glad to patronize as occasion offered. Very good meals were served here at moderate prices and we were waited on by ladies from the best Barbadian society.

We also visited Mr. Percy Haynes, who has a beautiful home perched on a hilltop near the Scotland District, and from which one gets a superb view of sea, valley, and mountain. In his garden and greenhouse we found many exceedingly interesting ferns and flowers which thrived splendidly in the moist district near the windward side of the island and under the expert care of Mrs. Haynes. Our entire party was delightfully entertained at the home of Mr. Swan, a leading commission merchant of Bridgetown, while individuals were the recipients of similar courtesies at the hands of many Barbadians.

But it would be impossible to make special mention of all of the homes in which we experienced the overflowing hospitality of "Little England." Enough has been said to show its quality.

The United States Consul, Mr. C. L. Livingston and his wife and family were like a bit from the home-land, and we often availed ourselves of the hospitality which they so freely offered. Swimming parties are quite the vogue at Barbados, and the

beach at the back of the consular residence is the finest that we saw. Our whole party enjoyed these events immensely, as well as the accompanying tea and other refreshments.

Mr. Arthur Gill, the man who first suggested Pelican Island for our quarters, was active in our behalf and secured tickets admitting us to the "Savannah Club," one of the main social centers where the leading men and women of Barbados are in the habit of congregating in the latter part of the afternoon to enjoy tennis and refreshments of various sorts. Mr. Gill is an enthusiastic yachtsman and owner of the "Mustang," a racing boat which at present has no rival here. On several occasions he took members of our party for a sail and incidentally proved himself a sailorman of the first rank. On one occasion he took us to the "fresh water bath," a place a few miles up the coast from Pelican Island where springs of fresh water bubble up from the sandy bottom near the shore. A novel mode of refreshments was introduced when oranges were thrown to the swimmers and they were expected to eat them swimming. To the naturally amphibious Barbadian this is easy enough, but we found our orange mixed with a generous allowance of salt water, which is said to improve the flavor.

With all these social activities I feared at first that the main purpose of our visit would be interfered with rather seriously. We found it possible, however, to confine them to the latter part of the afternoon when we were usually through with our work. We commenced operations rather early in the morning, worked hard in collecting and caring for material and attending to laboratory duties, and were usually willing to knock off at about 4:30 in the afternoon and enjoy the social side of life. We greatly regretted, however, our inability to return the many favors that were showered upon us. Our mess tables would accommodate no more than our own party, and we were not equipped to entertain. Many visitors called, however, and they seemed interested in our doings and declared themselves amply entertained by a visit to our laboratory and an inspection of the specimens to be found in the aquaria. The material obtained by dredging was seldom brought to the laboratory alive

and had to be put away at once, so that many of the most interesting novelties were not available for the entertainment of our visitors.

On Sundays some of us went to church, according to our preferences; others wrote letters and read, and still others took long walks on the mainland. Of course the Church of England is the leading one in the Colony, but several others, such as the Roman Catholic, Wesleyan, etc. are available. Parish churches are found all over the island, and the Sabbath is very universally observed as a day of rest and devotion. The negroes are dressed in their Sunday best and a fair proportion of them attend church.

Many of these churches are old and intimately connected with Colonial history, and the tombs outside and the memorial tablets inside would repay a detailed study, as they represent members of eminent British families who have lived and served since early in the seventeenth century and were indeed an essential part in the history of the Colony.

At Christ Church, near Oistins, we were shown the tomb, now unoccupied, which has a spooky story that would not do for nervous children before going to bed. It seems that several members of prominent families were buried there many years ago in very heavy leaden coffins; and when the tomb was opened, or reopened, to receive another occupant, these coffins were found shuffled and displaced in a most incomprehensible manner. Note was then taken of the position of the coffins and the tomb officially sealed. Sometime afterward it was again opened in the presence of several officials, only to find that these heavy coffins were again shuffled and some of them stood on end! Again with the utmost precaution against anyone entering the tomb, it was sealed and for the third time it was opened. Once more the coffins were found with their relative positions changed and one or more of them on end. Numerous solemn affidavits were signed and sworn to by witnesses, but the awful mystery still remains unsolved. I went into the tomb myself half expecting to be stood on my head, but nothing happened, perhaps because I had neglected the usual pre-requisite of being dead and securely sealed.

The old verger who showed us the tomb had an explanation.

He said that the gases formed in the bodies and confined in the air-tight coffins had caused them to *float about inside the tomb!* That man had a scientific turn of mind.

Over on the eastern side of Barbados, about two miles from the Crane Hotel is "Lord's Castle," a place with an interesting history. The following story struck me as one which would furnish an excellent plot for a short drama. It appears that the house was built by a man named Lord, which seems somewhat of a misfit. He was originally an ordinary fisherman living on the coast near Cobblers' Reef, a place ill-omened and exceedingly dangerous to vessels passing along the windward side of the island. The income of a Barbadian fisherman is far from princely but Sam Lord became wealthy, and it was reported that he had gone into one of the get-rich-quick schemes of that day and was quite successful as a wrecker, and that many an unfortunate vessel had been lured to the treacherous coast by lights shown by Sam Lord or his men.

However that may be, he became enormously rich for those times, built the stately mansion known as Lord's Castle, and married an English woman of excellent family. This unhappy woman soon found that she had married a monster of cruelty. Finding it necessary to go to England, Lord decided that it would be wise to lock his lady behind bars during his absence. This he did and sailed away.

His wife, however, prevailed upon some of the servants to release her, obtained passage for England on another vessel, which outsailed that of her lord and master, reaching England before that gentleman, whereupon she hied herself to her father's house and told him all. A short time after, Sam Lord made his appearance, was received by the lady's father as if nothing had happened, and proceeded to tell of the princely state in which he lived on his island home where his wife lived the life of an Empress whose slightest word was law to a vast retinue of servants, and most of all to Lord himself.

Then, presto, the wife appears and confronts him before her justly infuriated father and brothers. *Curtain!*

The city of Bridgetown is of course the political and social center of the Colony. The population is perhaps 25,000, and the crowded streets give an impression of a much larger town. The

focus of activity is Trafalgar Square, where there is a statue of Lord Nelson, a cab stand, and a meeting place for the various car lines. The motive power for these cars is in the form of mules, and the three or four lines radiate to various parts of the city. The cars are open, but with side curtains in case of showers. There are uniformed drivers and conductors, the latter with the largest and most imposing punches that I have ever seen. A printed receipt is given for each fare, and the rate is "tuppence" per mile, the service being quite regular in its schedule.

Rapid transit has its perils here as elsewhere, and prominent signs warn passengers not to get off while the car is in motion. A facetious citizen informed me that on one occasion a man fell in front of a car "and died of old age before it reached him." Seriously, however, these cars are a great public convenience and the service is remarkably good.

The cabs are most of them one-horse vehicles and have gongs which are quite musical, sounding like sweet-toned chimes, a distinctly more pleasant mode of warning than the outrageous klaxons and the other motor horrors. The drivers here turn to the left as in England. Many of them have a neat coachman's uniform and the whole outfit is often quite stylish in appearance. Motor cars are abundant and are owned by a majority of the well-to-do white people. Gasoline at the time of our visit was forty-nine cents per gallon.

The Barbados Government Railway is a steam line which runs from Bridgetown around by the east and north coasts to St. Andrews, passing by Bath and Bathsheba, popular bathing places on the windward coast. Passenger trains are rather infrequent and seem to run mainly for the purpose of accommodating week-end visitors to the bathing resorts. There are first, second, and third class cars; the first class, according to one native informant, is used only by two classes of passengers, first by government officials who do not pay fare, and second by "strangers who do not know any better." Sometimes "trolley parties" are indulged in. The trolley is a small platform car with seats for usually four people and propelled by negro boys, who push it from behind. This method is preferred by some

people who profess to believe it a more rapid mode of transport than the regular passenger trains.

I understand that plans for the improvement of this road, including electrification, were completed and some of the equipment imported before the great war caused it to be temporarily abandoned.

An autobus line runs along the west coast to Speightstown about two-thirds the distance to the northern end of the island. The fare is quite reasonable.

Hotel accommodations are ample, the largest caravansary being the Marine Hotel, at Hastings. A smaller but very comfortable place is the Balmoral, also at Hastings, where I found the proprietor, Mr. Armstrong, an exceedingly agreeable host. One of the most delightful resorts is the Crane Hotel in the parish of St. Philip on the east coast. It is situated on a high cliff overlooking the sea, which is usually rough on this coast and the breakers dash high on the rocks. Lord's Castle is within walking distance, and the strong breeze and invigorating baths make this a favorite place for a week-end stay. The seafood here is particularly good and I found a few days spent there on my previous visit to Barbados a distinctly enjoyable experience.

There is much novelty for the American in the streets of Bridgetown. In the center of the city he finds himself most attracted by the hordes of people jostling each other on the very narrow sidewalks and in the markets. They seem more alert than is usually the case with the blacks in tropical countries, and everyone seems busy. There are many donkey carts, the beasts looking more like magnified jackrabbits than anything else; also donkeys bearing loads of various sorts. As an auto rushes through the streets with its warning honk, the men or women, usually the latter, simply put their shoulders or thighs against the donkeys and push them out of the way. These women are by no means prudish about expressing their opinion of the auto drivers and that opinion appears to be far from complimentary.

Donkey carts seem to be used as delivery wagons to the exclusion of four-wheeled vehicles. Heavy loads such as punch-ions are carried on trucks with two large wheels and propelled

by negroes who rush them through the streets howling for right of way, which is granted without protest. But most of the produce is transported on the heads of women, often in large trays of baskets which look insecure, but none of us saw anything drop, although collisions between these crowds of bearers seemed inevitable. Often two women would stand talking unconcernedly, each with a weight balanced on her head which would in other places require a fairly strong man to lift.

We often saw a woman with a contraption like a water-cooler on her head, which contained some cheap drink. There was a faucet near the bottom and she carried a small cup. When serving a customer she held the cup up with one hand, turned the faucet with the other, made change, gossiped, and moved unconcernedly among the crowds, apparently for hours, with the big metal tank balanced on her head. It looked about the size of a five-gallon gasoline tank.

Passing along the streets away from the main business center one gets glimpses of the interior of innumerable little shops of various sorts. There are many licensed drinking places which have none of the allurements of our saloons, and vice here seems entirely unadorned.

In the residence district the streets are confined between high stone walls, often capped with broken glass after the English fashion. The British exclusiveness robs the casual visitor of much of the enjoyment that he would otherwise have in strolling along and admiring the numerous gardens and park-like grounds of which the Barbadians are justly proud. Most of the better class of citizens have gardens which seem well cared for, and as all sorts of tropical and semi-tropical plants thrive luxuriantly, they add much to the attractiveness of Bridgetown and its environments.

The most conspicuous tree is the flamboyant tree already referred to, and its great masses of scarlet flowers are in evidence almost everywhere. The Bougainvillia is scarcely less brilliant with its vivid display of dense clusters of purple flowers. Red, pink and yellow hibiscus add their colors to the general effect. Roses grow in profusion, and there are some very fine rose gardens. At Mr. Manning's place and also in the garden of Mr. Haynes are wonderful ferneries.

The royal and cocoanut palms in stately rows line the road-

side and form avenues that are more than ordinarily pleasing to the northern eye. The tamarind tree is wide spreading and affords a grateful shade in the parks, while the mango gives perhaps the deepest shade of all. The mahogany tree is also largely used for this purpose. Some fine baobab trees are seen, a superb specimen being in Queen's Park. Its curious compound trunk is some twelve feet in diameter. A noble silk-cotton tree may be found near St. John's Church. The grounds of Government House are like a large and beautiful park well laid out and well kept. Queen's Park is perhaps the most popular, while the grounds of the Imperial Department of Agriculture are well worth a visit.

This latter institution, under the direction of Sir Francis Watts, has charge of all of the Imperial Department of Agriculture of the British West Indies, including the Bahamas and Jamaica on the western extremity of that great chain of islands. There are a number of botanical gardens connected with these stations, and we visited those at St. Kitts, Antigua, Dominica, St. Lucia, and Barbados, and found them most attractive places. The department is mainly interested, however, in economic problems such as the sugar industry and the warfare against insect pests of various sorts. It is to these islands what our excellent Department of Agriculture is to the United States; it is well manned by trained scientists, often from the Kew Gardens, and it seemed evident to me that it is really the center of most of the progressive and modern scientific work in the West Indies.

It publishes the "Agricultural News," a fortnightly review of its activities. As an indication of its scope, I take the liberty of giving the table of contents of the last issue that has come to hand, dated October 5, 1918: *Agriculture as a Business Proposition, Agriculture in Barbados, Production of Alcohol from Wood Waste, Book Shelf, British Cotton Growing Association, Buchu Cultivation in South Africa, Copra and Coco-nut Oil, Curing Meat in Hot Weather, Department News, Intermittent Bearing of Fruit Trees, Gleanings, Influence of Records in Development, Insect Notes, Items of Local Interest, Market Reports, Notes and Comments, Plant Diseases, Rice Cultivation in*

British Guiana, Sugar Factory Control, The Crow and Its Relation to Man.

The Department also publishes the "West Indian Bulletin," a quarterly scientific journal, and a "Handbook and Pamphlet Series." The personnel of this organization did everything in its power to aid our expedition and in it we found most appreciative and influential friends to whom we are deeply grateful.

The Colonial Department of Agriculture under Dr. Bovell was also exceedingly helpful, particularly to our entomologist, who profited greatly by its advice and assistance.

The water-front of Bridgetown is a lively place, especially when several steamers are in the Bay. None of these come up to the wharves, but drop anchor in the open roadstead about half a mile from the shore. The landing place is protected by a solid stone mole. Numerous rowboats descend in a swarm upon the newly arrived steamer and the cries of the boatmen sound like Bedlam turned loose. This nuisance has been somewhat reduced in recent years by signboards which are held up by one of the men in each rowboat, giving the name of the craft, which is often fanciful. For instance, we were importuned by the "White Rose" and also by many royal personages.

A police officer stands at the head of the gangway, exercising autocratic control over the clamoring boatmen, adjudicating their quarrels and summoning boats desired by the passengers who go ashore. There is a regular tariff, but there are also frequent attempts to overcharge the customers on one pretense or another. After nightfall, however, a higher rate is legal. All of the freight is handled by heavy scows or lighters, most of them made of mahogany, which are propelled by negroes who stand on the gunwale and handle enormous oars or sweeps. The stevedores are also black men, often of superb muscular development and most independent bearing. They appear to work better here than at the other ports, but are also harder to control. The amount of freight handled is probably greater than at any other British port in the West Indies and it comes apparently from all over the world: from South and North

America, Great Britain, France, Italy, Spain, and even such ports as Calcutta, Bombay, and Melbourne.

At the time of our visit there was much excitement over the mysterious disappearance of the great Collier "Cyclops" whose last known port of call was Bridgetown. The officers and many of the crew were entertained by Consul Livingston. In conversation with him and others I discovered what seems to be a reasonable and easy way in which that vessel might have been captured and turned over to the Germans. I was informed that her Captain was a man whose name originally was German but had been changed. All that was necessary, provided he was a traitor, was to go ashore and then come off with the announcement that he had received orders to go at once to the North Sea, for instance. No one on board could question his authority and he could thus have taken the vessel anywhere that he desired and turned it over to the Germans. Some day doubtless this, one of the many mysteries of the sea, will be solved.

There was also much excitement over the U-boat raids on our Atlantic coast and innumerable rumors were afloat. Several steamers of the Quebec line were said to have been torpedoed and some of our party were a little panicky. Personally I dreaded the sinking of the vessel in which we were expected to sail for home *before we got aboard* more than I did such a disaster after we got started. The fear of being stranded in the West Indies with a party of nineteen who possessed no more funds than were needed to get home caused no little worry on the part of the director of the expedition. The loss of even one of these steamers would have meant a severe shortage of food on any of these islands and might have caused conditions bordering on starvation. Fortunately, none was attacked. Although they were armed with a single gun each, that would have added to the danger rather than decreasing it; as the boats were very slow and without convoy, the presence of the gun would in all probability have given an excuse for sinking without warning. Our party acted well, however, and after the first flurry of excitement over the ominous rumors, settled down to its work, and this in itself was an excellent antidote to the nervous excitement natural under the circumstances.

The difficulty of communication with home even by cable was

ominous. One one occasion a member of our party cabled for money, and it was a full month before he was able to get a reply.

On June 11th we commenced packing our collections and equipment for the transfer of the expedition to Antigua. As we began to assemble our material it became evident that our stay at Pelican Island had been profitable and the collections secured quite satisfactory, both in quantity and quality. We were confident that a reasonable number of new things would be found by those who were to prepare the technical reports on the various groups, and we had besides collected a quantity of specimens for classes in zoology at the University for many years to come.

Albert, our diver, had proved such a handy man, not only as diver and boatman but as collector and general utility man, that we decided to take him with us to Antigua, which seemed to please him greatly. We therefore secured from the Colonial Secretary a permit for him to leave the island, after promising to return him to Barbados after the completion of his service with us.

The business of packing was superintended by Mr. Stoner and Dr. Job, assisted by several others. Most of the equipment went back into the original boxes. The collections to be kept in alcohol or formalin were put in tanks, the tops of which were soldered. The bottled material was placed in the chests in which the bottles came, and some of it in tanks packed with excelsior. We found that the three barrels which we had bought to serve as floats for our live-car, and as a sort of main reservoir for the aquaria, served very well as receptacles for our corals, alcyonarians, etc. A few extra boxes had to be purchased for the geological collections and other dried material. By the morning of June 16th, the packing was completed, even to the personal baggage.

In the afternoon of that day we were invited to a sort of farewell reception at the residence of Sir Gilbert and Lady Carter, a very much appreciated courtesy as it gave us an opportunity to meet many of our good friends and receive their cordial God speed. We could not avoid a feeling of real sadness at parting from so many warm hearted people who had endeared

themselves to us by courtesy and hospitality that knows no limit; and it certainly warmed our hearts to receive the good wishes of his Excellency, Governor Fell and other officials and prominent citizens.

That evening it seemed to me to be proper to give public expression of our appreciation for all that had been done to make the expedition successful and our visit a happy one. I therefore published a card of thanks in the "Daily Barbados Standard" in which I tried to suitably acknowledge our indebtedness to our friends the Barbadians.

Early on the morning of June 17th, a lighter came for our effects, and the collections, equipment and personal baggage excepting hand luggage was loaded by 9:30 in the morning. Stoner and Job went to the "Korona" on the lighter and saw our effects safely on board, while Greenlaw and Willis Nutting took the hand luggage on the launch. I said goodbye to Pelican Island and went ashore to pay some last bills and make a few final calls. We took lunch at the "Self Help" rooms, where we were served an excellent meal. As an illustration of the thorough manner in which our interests were being looked after I mention the fact that while at lunch I received a telephone call from our good friend Mr. Sanderson, informing me that the corporal of police who had been sent to see our things safely transferred to the steamer had just reported that everything had been placed on board and the lists found to be correct.

We boarded the "Korona" about two in the afternoon and sailed at seven that evening. As we watched the dim outlines of Barbados fade away in the moonlight more than one of our party had a feeling akin to homesickness. None of us would have believed it possible five short weeks before to have so pronounced a feeling of sadness on leaving. Pelican Island will always be remembered as a home, and the Barbadians as friends with whom it is indeed hard to part; and we cherish the hope of again visiting "Little England" when the curse of war has at last been removed.

CHAPTER VII

ENGLISH HARBOR

The next morning at sunrise we witnessed from our portholes a sight that for splendor of coloring I never saw surpassed. We were gliding through perfectly calm water in the lee of St. Lucia off the sharp pinnacles of the Pitons, twin cones slender almost as church spires, twenty-six hundred feet high. Between them and framed by them the rising sun glorified a sea of fleecy clouds like ripples on a sand-beach of an intense fiery crimson changing to gold—the burning brilliancy of the iridescent breast of the ruby-throated hummingbird! The sombre blue of the mountains framed the picture on the right hand and on the left, while their shadows of deepest blue were cast on the brooding, quiet sea beneath. That picture of heavenly glory will remain as one of the most vivid of the entire cruise.

The cabins of the “Korona” were the largest and most comfortable that we occupied during our trip, although the ship itself is the smallest of the Quebec Line. Last year I enjoyed my return trip on her immensely, although she is only an old cargo boat not primarily designed for passenger traffic.

We did not come to the dock at Castries, the port of St. Lucia, but anchored in the beautiful little harbor and admired the surrounding hills with their rich vegetation and handsome villas. This is the most strongly fortified place that we visited, and is evidently an important naval base and coaling station.

In the afternoon we anchored off Fort de France, Martinique, to leave mail and take on passengers. Then a short run took us to Roseau, Dominica, which we reached about six P. M. We took a run ashore here and again visited the botanical gardens, this time by moonlight. There is little attraction, however, in a West Indian town at night when there are no lights, and we were soon willing to return on board. In the night we touched at Guadeloupe, leaving for Antigua about three A. M.

On the morning of June 19 we had a rough sea and some of the party were again suffering from *mal de mer*. Nothing "takes the starch out" of a person more quickly or more effectively than this curse of the sea.

I here renewed an acquaintance whom I had met on the same boat the year before, Sir Frederick Maxwell, Chief Justice of the Leeward Islands. His conversation was that of a keen observer with a legal way of looking at things, and his comments on the political and social problems of the islands and on the great war were intensely interesting. He was most anxious to impress me with the importance of the United States putting her whole power into the war, and at once. "It will need five million men next summer," he exclaimed, "Why do the things by halves!" As I write, two million Yanks have just done the job, thank God!

We reached the roadstead off St. Johns at 10:30 A. M. and had the busiest sort of a day before us. Mr. Collens, Government Chemist of the Imperial Department of Agriculture, was our efficient forerunner here, and he gave of his time and knowledge without stint and without compensation. He was methodical and business-like and we found him on hand, when the Government launch came wheezing alongside, with everything arranged to the smallest detail for our residence at English Harbor. The cooks and other servants had been engaged and installed. Provisions had been purchased and sent out and the transfer of our party and luggage provided for. Everything went off without a hitch, a marvelous performance for a tropical country where the "dulce far niente" spirit usually prevails. A sloop named "Resolute" came promptly alongside, while a Customs Officer, who had already boarded the "Korona" from the Government launch, at once carried out the arrangements which had been made through his Excellency, Governor Best, to pass all of our equipment and luggage without inspection and allow it to be transferred immediately to the "Resolute." Professor Thomas, Dr. Job, Wehman, and Willis Nutting sailed away in the sloop for English Harbor. Mrs. Thomas, Greenlaw, Ricker, and Ensign went around in Henderson's

launch the "Eolis Jr."; while the rest of our party went to St. Johns in the Government launch and thence to English Harbor by autos furnished by José Anjo.

While in St. Johns I attended to some financial matters at the Colonial bank and cabled President Jessup of our arrival at Antigua. The Governor had left a note stating that he regretted being absent for a few days on official business in the Virgin Islands.

The motor ride through the valleys between the hills to English Harbor was a matter of but thirty minutes. The road is good and runs between cane-fields for a while and then over a rougher region with picturesque villages here and there and many delightful glimpses of small thatched huts nestling under palms. As we neared our destination we skirted the blue waters of Falmouth Harbor. Then came the neck of the "Middle Ground" mud-flats and finally the entrance to the Dockyard through the massive gateway where the warden saluted; and at last we stopped in front of the Officers' Quarters destined to be our home for four weeks.

We found the servants awaiting us with their honest black faces beaming a real welcome, and also a few of our party that had preceded us in autos. Our furniture had not yet arrived, but quarters were selected and we had nothing to do for the present but stroll around and plan our campaign. It must be confessed, however, that most of our time was spent in watching the point of Fort Barclay around which we expected our boats to come bearing most of our earthly possessions.

The launch glided into view about five P. M., graceful as a swallow with a "bone in her teeth." She had had a rather rough passage around the windward coast, but was able to negotiate the seas without difficulty. She reported having passed the "Resolute" beating against the wind not half way to her destination.

Night drew on and still the sloop did not appear, and we became uneasy. After supper we stood on the veranda or on the sea-wall still watching. Darkness came and no sloop! We were without beds, bedding or any personal luggage. Most of all, perhaps, we regretted the absence of our mosquito nets, as the

malaria mosquito, which we had been told to expect here and which we dreaded more than anything else, was presumably abroad.

About nine o'clock Greenlaw, Ricker and I went in the launch to see if we could find the missing boat. After Barclay Point was passed we encountered rough water. The coast was rugged in the extreme with great black masses of rock looming up in the moonlight and the huge breakers dashing with a mighty roaring against the cliffs and gleaming white as snow against the blackness of the rocks. The scene was wild in the extreme, and the boat pitched and rolled like mad; but she was ably and most skillfully handled by Captain Greenlaw and we had no fears. We went out to the mouth of Falmouth Harbor but saw nothing of the sloop and turned back. Meantime Henderson and others had taken a lantern to Barclay Point to guide us in and we took this party aboard and returned to the dockyard at about ten P. M. with no news.

Having no bedding, we composed ourselves as best we could on canvas hammock-chairs, tables, and in some cases the stone floors of the veranda. The mosquitoes, fortunately, were not troublesome, and most of us succeeded in getting to sleep. A little after midnight, someone cried "Here comes the sloop" and we saw the "Resolute" gliding like a ghost in the moonlight toward the sea wall. All hands turned out to welcome the men on the sloop, who had for several hours been beating against head winds to make English Harbor. The mattresses and hand luggage were at once taken into the quarters and we were soon asleep again. All's well that ends well, but we certainly had an anxious time.

On the morning of June 20, we were all somewhat seedy on account of an almost sleepless night, but went to work early to unload the sloop and place our luggage in the quarters and the equipment in the large naval barracks assigned for the laboratory. Albert proved a great help, as his unusual strength and intelligence made the hardest work seem easy, and we soon had things in their proper places.

We were delighted with the display of marine life attached to the sea-wall that surrounded us on three sides of the Dockyard. There was the finest aggregation of tube-dwelling worms

that any of us had seen. Their whorled crowns of tentacles were in some cases as much as a foot in diameter. Henderson was enthusiastic over a beautiful *Murex* found in great abundance just below a band of oyster-like bivalves (*Perna*) that were attached to the wall just at low-water mark. There was also a fine display of jet black tunicates that were smooth and glistening as if newly varnished. A very large holothurian, such as the Orientals make *trepang* of, was abundant; and other riches revealed themselves as we more carefully examined this excellent collecting ground.

A number of the party donned their bathing suits and went to work at once. Some floated on life preservers, Miss Sykes had a pair of "water wings," and others simply swam along the sea-wall picking off the fine muricees until we had enough to satisfy the most voracious collector. Others busied themselves in putting the laboratory in final shape and assigning work tables. Several of the women went to work to put the sleeping quarters in order, placing mosquito nets over the cots, etc.

More picturesque surroundings could hardly be imagined than those we enjoyed here. The bluest of water almost encircled the Dockyard and the harbor itself is surrounded by high hills of volcanic origin and covered with tropical vegetation, most of it xerophytic in character, much like that of our southwestern semi-desert country. Right opposite the quarters was Barclay Point, with its picturesque ruins; while on the other shore to our left Clarence House stood on a wooded promontory. This is the summer residence of the Governor of the Leeward Islands.

Our living rooms were in the "Officers' Quarters" which had had far different occupants in the time when this was perhaps Britain's strongest naval base in the Lesser Antilles. The building is about 100 feet long, by 30 wide, with the lower story occupied by immense cisterns, storerooms, etc. The upper story constituted the quarters proper. A very wide stone-flagged veranda ran along nearly the whole length of each side. At one end were the dining room and a room opening into it used for storing dishes, a cupboard, etc.; while at the opposite end was a large room used as a sleeping room for most of the unmarried men of our party. Between these end rooms was a

series of six suites of large rooms, each pair opening into one another and the front rooms having a door and window opening upon the veranda. The back rooms opened correspondingly onto the back porch, as we called it.

Broad stone steps led up to the veranda at the center of each side of the building and a corridor crossed between these opposite stairs. Heavy storm shutters and blinds were in all the windows and the upper parts of the doors, allowing the free passage of the sea breeze which almost constantly blew in from the ocean, making it delightfully cool at all times. Indeed this trade-wind was often too strong for comfort, blowing our clothes off the hooks inside the rooms and papers off the tables. This constant wind "got on our nerves" at times, and we could well have dispensed with a considerable part of it.

The laboratory was in a building 100 feet square, used in olden times as quarters for the jackies of the British navy. The laboratory facilities here were not so convenient as at Pelican Island, as they were not quite so near the water in the first place, and were upstairs, which necessitated carrying up of all the sea-water that we used. The stairway, moreover, was steep and narrow. In spite of these drawbacks, the space was ample for our needs, and plenty of light and a superabundance of fresh air were available. It is true the roof leaked in spots, but at infrequent intervals, and we had little that could be seriously injured by water anyway. Of course we could not do much in the way of keeping aquaria going under these conditions, but this was of little moment as we had one of the most wonderful natural aquaria just in front of us.

The great cisterns in both of these buildings furnished an ample supply of fresh water for all purposes. This, while not so good as that at Pelican Island, was fairly satisfactory; although not very palatable, especially as the ice supply was inconstant and the temperature far higher than we fancied. We were inclined to attribute the slight attacks of bowel trouble from which most of us suffered from time to time to this source; although it is quite as likely that it had other causes such as long hours of work collecting under the hot sun, which made us feverish at times and resulted in a too free use of the water. On the whole, our health was good here, none of us being under

the weather more than a day or two and no serious symptoms manifesting themselves. There were no cases of malaria, for which we were indeed thankful.

Elephantiasis is rather common on Antigua, and I was somewhat surprised to learn that a number of white people are afflicted with this disease. Probably the fact that the blacks wear costumes which leave the lower part of the legs bare is responsible for the notion that only the blacks are afflicted.

The kitchen was in a small building some distance from the quarters. This arrangement had its drawbacks, as it necessitated carrying the food about a hundred yards to the diningroom and it was hard to have it served hot. Our servants were a housekeeper, cook, assistant cook, maid, a boy and a little girl. Mr. Lake, the caretaker, Corporal James of the Police Force, and Page, the gatekeeper, were employed by the authorities to look after the government property at the dockyard.

There was less trouble in dealing with the servants here than at Pelican Island, and we found them in general more willing to learn our ways, and seemingly more eager to please.

Albert Ashby, whom we brought from Barbados, was a great help in many ways. He developed real interest in collecting and was useful as a boatman. He proved much more resourceful than the natives; and his strength and activity, as well as his intelligence, made him a very useful man of all work. On one occasion I took him with me to secure some large land-crabs, orange brown with bright purple and white chelæ and exceedingly hairy legs. These lived in the oozy mud of the mangrove swamp and were quite difficult to secure. A native that I employed failed entirely. Albert, however, armed with a spade, would make a dive into the swamp, flounder around a while, and emerge with as many as three of these large crustaceans in his hands. Some of them had a spread of over fifteen inches and their pincers were really formidable.

We hired a rowboat owned by a neighboring fisherman, for eight shillings per week. It was crude and hard to row, but served very well in the quiet waters of the harbor.

There were a number of buildings at the Dockyard besides those occupied by us, which were solidly constructed of stone and brick but had not been kept in good repair. One was

called the "Capstan House" and was practically empty, but contained a much prized memento of royalty which we were allowed to inspect as a special favor on the fourth of July. Mr. Blake escorted us into the building and unlocked a couple of doors which, upon being thrown back, revealed an inscription painted on the white wall, reading:—

"DONE B. H. R. H., GEORGE V, IN 1883 WHEN SERVING ON
H. M. S. CANADA

A
MERRY XMAS AND HAPPY
NEW YEAR 2 YOU ALL"

Another building had been used as a machine shop and one had an inclined plane running down to the water and had evidently been used as a sort of dry-dock, the ship being drawn up from the water by windlasses. One building was a complete mystery to us. The floor was of solid stone and there were rows of heavy masonry pillars, each with a dome-shaped cap of cement as if the structure had never been completed and the pillars had been capped to prevent their disintegration by weathering. No one seemed to know the purpose for which the building was intended.

There was a large and exceedingly convenient boathouse which accommodated our launch very nicely, where it could be kept under roof. Another building resembled one of the block houses in which early settlers in the United States defended themselves from the Indians. There were numerous slit-like apertures in the walls through which riflemen could fire on approaching enemies.

Back of the sea-wall there were set a number of old cannon, their butt-ends buried deep in the earth and cement. These doubtless were mooring posts, probably also used in careening ships. At one place a large anchor lay on the ground, commemorating a tragedy which occurred early in the last century when Lord Camelford shot and killed one of the lieutenants of the British Navy for "mutiny." It appears, from all that we could learn, to have been a most cold-blooded murder. No spot in the British West Indies has richer historical interest than English Harbor, but we could not find that any detailed story of this place of innumerable traditions had ever been compiled and

it seems evident that there is a rich field here for some student who enjoys digging up stories of the olden time.

The grounds are well kept and levelled, with green turf which is cropped close by a small herd of goats. Here and there are huge iron kettles used for boiling pitch so necessary for calking the wooden ships of those days. The whole area is cut off from the mainland by a high stone wall opposite the sea-wall. The entrance is through a great wooden door over which a lantern is suspended. A building occupied by Corporal James and another for the gateman were on the lefthand side of the gate as one entered. A very fine flamboyant tree is in front of the caretaker's house just inside the gate. This was in full blossom during our stay, and formed a truly gorgeous ornament to the grounds.

Stone steps led from the top of the sea-wall to the water in two places in front of the quarters and laboratory. These were very convenient for bathing, and it was a delight to run out and take a plunge in the cool water before dressing for the days' work. An excellent sundial on a solid stone pier and protected by a circular iron fence was really a great convenience, giving the time quite accurately; at least within five or ten minutes, which sufficed for our purpose. This indeed was better than most of our watches were doing by this time.

Taking it all in all we were very comfortable here and never really suffered from the heat. Although we had a number of rain-squalls, they interfered little with our work, and there was only one bad storm.

Our commissary department was rather more difficult to manage here than at Barbados, owing to the distance, over eleven miles, from the market at St. Johns. Fish and the greater proportion of fresh vegetables were furnished by parties living in the neighborhood. The supply of the former was never so ample nor so good as at Pelican Island. They were apt to be brought in so late that it was necessary to cook them and keep them over night, so that when they were served they were far less palatable than if cooked and eaten at once. Meats were not always to be had; but we were fairly well supplied, and the price was reasonable. Pork, mutton, beef, and goat's meat were usually available, and there was a fairly adequate supply of

fresh eggs, which were brought in by the farmers in the vicinity.

Sweet potatoes, yams, rice, cornmeal and sugar were reasonable in price. Fruits, however, were scarce, and the supply of oranges and bananas, which were always to be had at Barbados, was exceedingly precarious here. A few watermelons were generously donated by Miss Gillie, who kept the Hotel Esperanza at St. Johns. There was one tropical product, however, which was to be had in abundance, and that was the pineapple, or "pine" as it is invariably called. These were simply delicious, the finest in flavor that we had ever tasted and they cost but nine cents each! We fairly revelled in them, and their abundance made up in large measure for the lack of oranges and bananas. We also secured a few avocados or "alligator pears" which, although very much relished by some of us, did not take well with others. The taste for them seems to be an acquired one with many people, although the writer has been exceedingly fond of them for many years and was delighted with the first that he enjoyed many years ago in Costa Rica.

There was also a fruit called "cherries" which were tempting to the eye, but not much of a favorite with us unless cooked and served as a sort of jam. They were not at all related to our cherries. We also were introduced to a "wild apple" which was not an apple at all. As a matter of fact, the only tropical fruits that can at all compare with our northern products are the familiar orange, banana, and pineapple. No others that we encountered found general acceptance by our party, although certain ones were more or less enjoyed by certain individuals.

Twice a week supplies were brought out from St. Johns on a donkey cart. On other days they were brought in a huge basket-work tray on the head of a buxom girl. Sometimes the load weighed as much as sixty pounds. This was carried nearly twelve miles to the dockyard, and then the girl returned to St. Johns. Her compensation was the princely sum of seven pence (fourteen cents) per trip. This stipend was allowed her by the grocery firm with which we dealt, which showed the commercial enterprise to charge us a shilling (twenty-four cents) for the service.

When we found it necessary to go to St. Johns on business, we

had to pay for an automobile about one pound or \$4.80 per trip; as it involved two round trips, the car being hired to come out from town and having to return to St. Johns after taking us back to English Harbor, the actual cost was nearly \$10 per round trip. Sometimes, however, we went in the launch when the wind on the south coast was a little less violent than usual, and the cost was merely that of gasoline used at the rate of about fifty cents per gallon.

Although exceedingly anxious to dredge off the coast of Antigua, we were able to do almost nothing in that direction, as the seas were entirely too high to make dredging with the 27-foot launch at all safe. Several attempts were made and a few specimens secured, but it was precarious work at best, and we were finally forced to give it up, much to our regret, and confine ourselves to English Harbor, Falmouth Harbor, and Willoughby Bay. The bottom here, however, was usually covered with very fine mud or silt, which was far from rich in animal life, although some interesting mollusks were secured.

The shallow water, shore, and reef fauna, on the contrary, was exceedingly rich and we soon found that our most profitable course of procedure was to work this territory as intensively as possible. There was, moreover, a considerable difference in the faunæ of the several harbors in the vicinity, and thus we found it profitable to work them all as thoroughly as practicable.

Our favorite collecting ground was near what we called "Rocky Point," across from Barclay Point and inside of the Pillars of Hercules. Here at low tide we almost daily reaped a rich harvest in the tide-pools and by lifting the loose-stones. This involved considerable hard work in the full glare of the tropical sun, and the continual bending over and lifting the often very heavy rocks made our backs ache. Three or four hours of this were enough for even the strongest of us. Albert's great strength was utilized in this work to very good advantage, and his zeal and intelligence added materially to our daily catch.

The echinoderms were perhaps the most conspicuous group at this place, although most of the species were the same as those secured at Barbados. At the foot of the Pillars of Hercules,

certain species found a refuge in the cracks of the rocks that were continually being scoured by the waves. On these rocky flats everything seemed to be stuck tight and had to be forcibly pried loose. There were small holothurians that wedged themselves in these cracks and held on with remarkable tenacity.

A great number of worms, mostly of the tube-dwelling kind, were found in the rocks at Barclay Point, while the sea scorpions were apt to lurk under the stones and sting the hands of the incautious collector. Of course there were crabs innumerable, and many shrimp-like macrurans. Anemones, too, were plentiful and of different species from those collected at Barbados. Some of them were of the social kind and encrusted the rocks in places.

Almost innumerable mollusks were found attached to these rocks, and Henderson made several interesting finds. A fine study of individual variation and variations at different heights from the water could be made here and was made to a certain extent. Some specimens of chitons new to us, including a small red form, were also found. Here, too, we encountered the "sea punch," which is a worm-tube, hard as flint, cemented to the rock, with a perfectly round aperture pointing upward. One of these punched a neat round hole in the horny sole of Albert's foot as clean as a conductor could "punch with care" a passenger's ticket. We thus had a demonstration of the exceeding appropriateness of the name "sea punch," although Albert limped around for several days as a result. Here also we found a number of brown petalostichans that were buried several inches in the sand under the rocks, and a remarkable holothurian (*Eupata*), quite transparent and with encircling rings of curious round nodules that disappeared when the animal was fully extended. On the seaward side of Rocky Point several species of corals were found, and *Millepora* which grew in a peculiar reticulate pattern where the surf swept heavily over the flat rocks near the foot of the Pillars of Hercules.

Across from Rocky Point is Barclay Point, on the outer side of which the surf beats heavily, although there is comparative quiet on the side facing the Dockyard. The point is high and the rocks precipitous, while below are masses of black rocks between which are some good tide-pools where we collected many

interesting things, especially crustaceans. One was a large "pistol crab" that lurked among the tentacles of an anemone and struck the finger of the collector a sharp blow with the point of its large chela. It felt much like an electric shock and made one jump every time.

In Falmouth Harbor we found patches of growing coral reefs, including *Porites* and fine specimens of *Manicina*. A peculiar species of *Porites* was collected here, resembling *P. clavaria*, but intense deep purplish blue in color. Extensive mud flats partly covered with eel-grass were populated with several sorts of sea-urchins. These were mostly the common *Diadema*, *Hipponöe*, and *Toxopneustes*. *Hipponöe* has the habit of covering its dorsal surface with pebbles, eel grass, etc. Some of our finest anemones were collected here, and Fisher discovered a number of the largest colonies of *Pennaria* that I have ever seen. *Oreaster reticulatus* was also secured.

There were extensive mangrove swamps fringing the inner harbor back of the Dockyard and we found excellent collecting among and in the maze of prop-like mangrove roots. Many serpulid worms, oyster-like bivalves (*Perna*) and holothurians were thus secured. Here also we found the enormous hairy-legged land-crab; and, still further back, armies of fiddler crabs which scurried over the muddy flats.

We went several times to Willoughby Bay, although the passage around the windward coast was very rough. There are fine reefs stretching nearly across the entrance of the bay, but the coral seemed to be of the ordinary species already studied at Barbados. The bottom is mud and fine sand and not rich in animal life.

We did some night work in English Harbor, using an electric light suspended from the stern of the rowboat and about a foot beneath the surface. The catch was mainly small eel-like fishes and the curious half-beaks (*Hemirhamphus*) with a very long tubular lower jaw ending in a phosphorescent organ, and hardly any upper jaw at all. There were many ribbon-like "ghost fishes" which were so transparent that they could not be seen in a bucket of water. Most of the forms collected in this way were more or less phosphorescent.

With all these rich collecting grounds, it will be evident that

our party found plenty to do at English Harbor, in spite of the failure of our plans in regard to dredging off the coast of Antigua. What little dredging we did inside the bays was very hard work, as the sticky fine mud had to be sifted through the sieve which was held over the side and swashed up and down in the water. This was as back-breaking a task as I ever tackled, and an hour or so was enough to satisfy my ambition, particularly as the results were poor from a zoological standpoint.

We did not confine ourselves to marine forms, however. Mr. and Mrs. Stoner reaped a rich entomological harvest at the peril of their lives, as they returned sometimes almost done up after a day's work in the close tropical jungle. Professor Thomas was also successful in his geological collecting and secured what is doubtless the largest series of fossils that has thus far been taken from Antigua. His energy knew no cessation and his strength was equal to continuous work even in the tropics. He was perhaps the most indefatigable collector in our party and willing to help anyone else whenever occasion presented itself.

Under the guidance of the Rev. Hal Shepherd we made a most interesting excursion to "Bat Cave" on the other side of Shirley Heights. The trail led up by Clarence House, across the ridge through some very thick jungle and then across a stretch of grassy, rock-strewn country. The mouth of the cave is well concealed and might be easily overlooked if one tried to find it without a guide. Inside is a chaos of broken rock as if great masses had been dislocated by an earthquake. The passage leads down rather abruptly and soon plunges into utter darkness with deep fissures and crevices all around and beneath us, making the locality a dangerous one to explore without good lights. We were provided with two rather feeble electric torches, upon which not very much reliance could be placed. Rev. Shepherd had brought along a stout cord about seventy feet long. As the leader of the party, I elected myself to the arduous task of holding the end of this cord, squatting down on a rock where the last glimmer of daylight could be seen, thus generously allowing the rest of the party to enjoy the further exploration of the cave. They went on with the two lights and the other end of the cord, soon passing around the point of

the rock; and I found myself alone in the most utter darkness, afraid to move in either direction for fear of falling into one of the great cracks at my feet. Thousands of bats were circling around and twittering in wild excitement with a constant whirring of wings. Every once in a while one would strike the cord, which would twang like a fiddle-string. For reasons perfectly obvious to those who know me, I had no fear of their becoming entangled in my hair, according to the popular superstition. I could hear various thumps and exclamations issuing from the Stygian darkness beyond, as the rest of the party whacked away with their dip-nets after the bats. It was hot and exhausting work and the air was simply stifling, rendering it unsafe to stay more than a few minutes. A reasonable number of bats were secured and placed in a tank where they were chloroformed. The lights appeared in the distance, my companions climbed laboriously upward to where I still sat, and we all thankfully emerged into the pure air and sunlight of the upper world.

On the way back we passed a region where logs of fossil wood were strewn over the ground, most of it silicified and its structure very well preserved. We took such specimens as we could carry and reached home about supper-time pretty well tuckered out.

In the afternoon we usually worked over the material secured earlier in the day and after 4:30 were often occupied in entertaining visitors, officials and planters usually, who came in automobiles and remained an hour or so according to local custom. Governor Best spent the week-end several times at Clarence House where he entertained us at tea. He also honored us with a call soon after our arrival.

July 4th was a memorable day with us. Soon after breakfast I received a telephone call from the Governor, who felicitated us on our national holiday and sent a message of hearty good will, which was but one of the many thoughtful attentions shown us during our stay. A little later Mr. Potter, a resident of the village of English Harbor, called and desired an interview. He was very impressive in manner, bowed profoundly and said that he understood that this was "The American Xmas." I informed him that we regarded it as a national rather than a

religious holiday. He asked permission to help us celebrate by bringing a string band of which he was leader and "give us music." We accepted the offer with thanks, and in a very short time heard the music approaching through the gate.

The band consisted of six pieces. There were two guitars, a mandolin, a violin, a triangle, and a "pipe." This latter was an instrument quite unique in our experience, consisting simply of a section of two-inch gaspipe, one end of which was bent like an umbrella handle. A small boy was the executioner attached to this contraption and blew into it most vehemently with cheeks inflated almost to a bursting point. The result was a series of deep bass grunt-like sounds all of the same pitch and at regular intervals. This instrument served the purpose of marking time and was evidently a device to take the place of a bass drum or viol; and it really served very well, although we could not help being somewhat concerned about the performer, who was so constantly inflated that we feared a catastrophe.

The band marched around to the front of the Officers' Quarters, countermarched at the command of Potter, the drum major, and played voluminously and continuously. We had secured a British flag from Clarence House and flew it side by side with the stars and stripes from the top of the stairway in front of the veranda. The servants dressed in their best, appeared and commenced an impromptu dance to the music. The ponderous cook was whirled around by the venturesome Potter himself, while Albert proved himself an adept at the terpsichorean art with the aid of one of the maids. The dancing was characterized by a peculiar movement of the hips and shoulders, the feet shuffling in time with the music and hardly leaving the ground at all.

The band and audience took a rest for lunch, but the exercises were resumed afterward. This time the entertainment was on the veranda. Like certain railways, this band was characterized by poor terminal facilities, and seemed bent on making a full day of it. Finally, by a judicious application of coin of the realm to the palm of their major domo, they were satisfied that their full duty had been performed and we were relieved of our anxiety regarding the inflated boy.

Several of our party celebrated the day by taking a motor

ride over the island. The rest of us gathered on the veranda in the afternoon and listened to a Fourth of July speech by Ricker. The Rev. Mr. Shepherd, with others, had called to celebrate the day and he accepted an invitation to speak, giving an excellent impromptu talk entirely appropriate to the occasion and expressing a cordial appreciation of the United States and the significance of the day, which certainly warmed our hearts.

On June 27th we gave a farewell dinner to Henderson, who was compelled by reason of business engagements to return to Washington. Some of us took occasion to tell him frankly what we thought of him, which fortunately was all to the good. My notes under date of June 27th express the feeling of the director of the expedition as follows:—

“We are all somewhat depressed over the fact that Henderson leaves us to-morrow to sail on the “Guiana” early Saturday morning. He is easily the most popular member of our party. Aside from the tremendous aid that he has rendered with his launch and the services of Greenlaw, he has helped still more by his constant cheerfulness and good nature. His unfailing courtesy has fallen alike upon the just and the unjust and he has “fitted in” to our party admirably. His scientific attainments and zeal as a naturalist have been an inspiration, and he has been an immense aid and comfort to me personally.” As one of the men expressed it, “Henderson left a big hole in the party.”

On July 9th, Albert Ashby, our diver and general utility man, returned to Barbados and left another big hole. I rather suspect that there was sorrow in more than one dusky breast at his departure. His work with us had been entirely satisfactory, and we found him an exceptionally good man, quiet, but with a sense of humor that made him worth listening to. At one time when returning from a fruitless excursion of some sort, another boatman asked “What you got?” He answered, “Mon, I got a boat full of emptiness.” He was a good deal of a dandy when dressed up for Sunday and exceedingly neat and clean in his personal habits. We chipped in and gave him a parting gift that he received with dignity and evident satisfaction. I went to

St. Johns to see him off, and felt when I shook hands with him for the last time I was saying goodbye to a real man. May the world serve him as he served us!

Sir Francis Watts was on the "Parima," returning from a tour to Jamaica and the Bahamas in the interest of the Imperial department of Agriculture, of which he is the head. As he had done more than anyone else to encourage our expedition to visit Barbados and Antigua and had been very largely instrumental in securing the excellent quarters which we occupied at both places, I was exceedingly glad to see him again, even for a short time. We greatly regretted that he was unable to pay us a visit at English Harbor. He did, however, take breakfast with us at the Hotel Esperanza and we much enjoyed the all too brief visit with this "God-father of the expedition," as we called him. With him were Dr. H. A. Ballou, Entomologist of the Imperial Department of Agriculture, and his wife, who had had an interesting experience.

It seems that he had been detailed to investigate a problem in connection with economic entomology in Egypt. Having completed his work, he and his wife were anxious to return to Barbados; but on account of the war and the U-boat menace in the European war zone, they decided to go east by way of the Orient and Pacific, across the American continent to New York, and thence via the Quebec Line to Barbados. After several vexatious delays on account of steamers on which they had reckoned being requisitioned for war purposes, and after the lapse of nearly six months *en route*, they reached New York and sailed for Barbados just at the time the U-boats were operating off our Atlantic coast. Thus, after all their trouble to avoid this danger, they were forced to run the gauntlet on the last lap of their circumnavigation of the globe.

On the evening of July 10th some of the younger people arranged a dance to which the servants and a few of their friends were invited. The function was held in the big laboratory room and illuminated by the searchlight from the launch installed by Greenlaw. A row of wooden pillars separated the white dancers from the black, and music was discoursed by the justly celebrated "string band" that had served us so strenuously on the fourth of July; but the impressive Potter was ab-

sent and a man instead of a small boy inflated himself in producing the well-timed grunts from the gas-pipe.

I never saw people show such an ecstasy in dancing as did these negroes. The sex element did not enter into it largely, for there were but two or three men dancing. One old woman in particular interested us greatly. She danced alone practically throughout the evening. Like most of the others, her head was surmounted by a turban, and her feet were bare. She held her hands in front of her in the posture of a begging poodle, and with eyes half closed she shuffled her feet in perfect time to the swaying of her body and the rhythm of the music. The expression on her face was one of trance-like ecstasy, as she danced on and on so long as the music lasted; her soul lifted above her environment, sublimated, communicating with the unseen. Seeing her and others, particularly of the older women, gave me an insight into the force which music and dancing have always exerted as parts of religious ceremonies, that I had never before realized. If David "danced before the Lord" with the spiritual ecstasy that this old negress exhibited, it was an act of the highest religious fervor and was doubtless as acceptable as the devoutest prayer.

Corporal James' sweetheart was evidently the belle of the ball and was really a strikingly handsome girl, of Juno-like frame and dignified bearing. She would have graced a far grander ball-room. As a climax, the white people all joined in a good old-fashioned Virginia reel, much to the edification of the negroes.

Unfortunately, however, this was not the end of the affair, although I did not know it until the next morning. It appears that the "man" of one of our maids was incensed at his "woman" for attending a ball to which he was not invited, and gave expression of his disapproval by knocking her down, kicking her in the ribs and attempting to drag her out of the gate. She screamed and the ever-chivalrous Ricker went to the rescue. Quite a crowd gathered at the entrance. The man was truculent and showed fight, when Greenlaw appeared on the scene and was told by Ricker to tackle the offender. This he promptly did, knocking him down without striking him, and choking him into submission. He was then thrown out of the

gate. Corporal James seems not to have been on duty. The next morning the maid appeared with a badly swollen head and bruised sides. She seemed to regard the affair as a rather to be expected and by no means unusual domestic incident. I summoned the Corporal and reported the affair, explaining that no American could stand by and see a woman abused, and that I approved of the conduct of our men. The culprit disappeared to prevent arrest, but afterward came to the Dockyard and apologized for his conduct. The other negroes seemed to think that he had been properly punished, and that ended the incident.

On the morning of July 11th Mr. Wehman went out by himself to take some photographs, and, not intending to be gone long, failed to notify us as to his movements, which was quite contrary to his usual custom. He did not return for lunch, which caused little comment, as he was apt to become so absorbed in his work as to forget such commonplace details as meals. Evening came on and still he did not make his appearance. In the middle of that night we had the most violent tropical storm experienced during the cruise. The wind for a time blew with hurricane force, and the rain came in tremendous volume. Our sleeping rooms were drenched by the rain driving in through the shutters in spite of a very wide veranda which ordinarily protected us. We woke to find the bedding soaked, as well as the clothes which had been blown off the nails on which they hung. I rushed to the back of the two rooms occupied by my family and myself, carrying an armful of clothes and slamming the door after me. To my dismay, I found that I had jammed the door so that it was impossible to go after our remaining clothes to save them from a further wetting, so there we were in night apparel and the rest left to its fate. After some time, however, we succeeded in prying open the door, and found that some of our effects were still fairly dry, much to our relief.

We were worrying a good deal about Wehman, out alone in that fearful storm. We felt that had he sought shelter at any of the estates, he would certainly communicate with us by telephone. Morning came and still no news of the wanderer. After breakfast I notified Corporal James and he communicated

with Colonel Bell at Police Headquarters in St. Johns. The matter was taken up very vigorously and a detailed description of the lost man was telephoned to every plantation on the island, while Corporal James gathered a search party at Falmouth. I knew that Wehman was well able to take care of himself, but could not understand why he failed to notify us of his whereabouts by telephone. The only explanation seemed to be that he had met with an accident in some lonely spot in the jungle where it would be difficult to find him.

About nine o'clock that morning, however, I received a telephone call from our good friend the Rev. Hal Shepherd, who said that he had seen Wehman, who was on his way to the dockyard. Before long the prodigal returned and was a sight to behold. He had been soaked through and through, his helmet was drooping over his ears in a most dejected manner, he was spattered with mud, and his clothes were in tatters. A hot breakfast had been kept for him, he secured a good wash-down and change of clothes, and was soon in bed for the rest which he badly needed. His story was as follows:

After starting on his walk, it occurred to him to go to the top of Sugar-Loaf Mountain, one of the highest and roughest peaks in Antigua. He reached the summit about noon and decided to lie down for a rest, when he promptly went to sleep and slept until the afternoon was rather well advanced. After taking some photographs, he started back, only to find that his field-glasses were missing. He then tried to retrace his steps to find the glasses. This took considerable time and he failed in his search. Evening was then coming on and he did not dare to try to make his way through the jungle and steep descent in the darkness. There was no house of any kind in the vicinity, and he decided that the best thing was to pass the night in the lee of some rocks on the mountain-side. As luck would have it, he had chosen for his picnic the night of the worst storm in months, was thoroughly drenched, and had a wild time of it in general. When dawn came he had been without food for nearly twenty-four hours. Coming down to the valley, he discovered a cow and succeeded in playing the Romulus and Remus act. Thus refreshed, and with the further sustenance secured from a couple of mangos, he came home to find himself the best adver-

tised man on the island of Antigua. This was particularly distressing to one of his notably retiring disposition. Furthermore, it was evident that he would have to behave himself circumspectly during the remainder of his stay, as every member of the police force had his complete description with all the marks of identification set forth in detail.

He himself did not regard his adventure as anything to make such a fuss about, and called it merely "an interesting experience." All's well that ends well; but the director of the expedition looks back upon the anxiety of that night as one of the most unpleasant experiences of the whole cruise. Wehman, I am glad to say, was none the worse after a few hours of rest and was at work again as usual before evening.

Owing to the distance, nearly twelve miles, to the city, we were not so much occupied by social matters as at Pelican Island, although we enjoyed calls from many officials and planters. We therefore inaugurated a series of informal discourses on the veranda. These were usually booked for 4:30 in the afternoon, when the day's work was about over. Henderson gave a talk on the mollusca, Fisher on the holothurians of the region, and Thomas told us about the geological problems and his experiences both at Barbados and at Antigua.

The moonlight nights were delightful, and sometimes inspired us to music, at which time Stoner's mandolin was our main resource; and songs never heard before in that historic spot doubtless disturbed the slumbers of our neighbors. The picture will remain always with every one of us,—the moon rising in round-orbed splendor over Shirley Heights and turning the placid waters of the harbor to burnished silver, the sharp silhouette of the ruined fort on Point Barclay right opposite; the gleam of the breakers as they mounted high on the rocks on the opposite side of the harbor entrance; the sweet chords of the mandolin mingling with the voices of the singers; the quiet content of resting after a hard day's work in the sun; the caress of the evening breeze; and, for the unregenerate, the aroma of an evening pipe—this picture is one of those which constitute the choice treasures of the soul, more real than riches and more precious than all save friendship and love.

CHAPTER VIII

ZOOLOGICAL NOTES, ANTIGUA

VERTEBRATES, CRUSTACEA, MOLLUSCA, AND ECHINODERMS

The work of the expedition was devoted almost entirely to marine forms and insects, practically no real effort being made to study land vertebrates. Incidentally, however, a few mammals came under our observation, and perhaps the most interesting of these were the bats.

Under the roof of one of the large buildings in the dockyard, known as the "Capstan House," there was a roosting place for thousands of bats belonging to the family Phyllostomidæ. They issued forth in a regular swarm shortly before dusk, and it is doubtless due to their activity that so few mosquitoes were found here. They apparently belong to the genus *Phyllostomus*, as defined by Miller in his "Families and Genera of Bats," 1907, p. 122; the dental formula being $i. \frac{2}{2}$, $c. \frac{1}{1}$, $p. \frac{2}{2}$, $m. \frac{2}{3}$ the last molar being minute. The nose-leaf is strictly triangular, with deep grooves dividing the central horn from the lateral lobes. The ears are not very large for this family and are not united by the membranes extending over the top of the head. The tail is absent and the interfemoral membrane has an obtuse point just above each heel. The color is grayish brown above. Quite a large series of specimens was secured, many of them being gravid females and yielding abundant material for future study of the development of this species.

Another species was secured on the visit to "Bat Cave" already referred to. This also belongs to the family Phyllostomidæ, but has no true nose-leaf. The head is much stouter than in the preceding species and the nose is truncated like that of a pig, which indeed it resembles in miniature. The dental formula is $i. \frac{2}{2}$, $c. \frac{1}{1}$, $p. \frac{2}{2}$, $m. \frac{3}{3}$, exactly that of a man, by the way. The molars are peculiar in having very broad flat crowns rising into a conspicuous sharp cutting ridge on the outer side; canines with a large postero-lateral cusp. The first upper premolar is minute and laterally displaced so as to be on the out-

side of the base of the canine. The mouth has a peculiar expression owing to the wide triangular cleft in the lower lip, the sides of which are fleshy and bare, showing on each side six rounded parallel ridges giving a ctenate appearance. This structure is, I believe, peculiar to the genus *Chilonycteris*, to which this species appears to belong. The color is dark brown with a plumbous cast.

We were told that attempts had been made to use the bat manure from this cave as a fertilizer. I imagine, however, that it would be hard to secure any considerable quantity as it would have to be scraped from the surfaces of the angular masses of rock which form the floor of the cave as far as we explored it.

Mr. Collens told us, by the way, that there was a species of fish-eating bat, *Noctilio leptrinus* on Trinidad, and showed us an item in the "Journal of the Field Naturalists Club of Trinidad," giving a detailed account of this strange habit. Mr. Collens' personal observations are as follows:

"I have time after time seen them catching fish (*Girardinus Guppyi*) a minute viviparous fish called locally 'millions,' which used to exist in the shallow concrete drains in Tranquility, Port-of-Spain. The same or a similar type is to be seen any evening, being especially visible on moonlight nights, skimming the sea surface in search of small fish anywhere about the small islands in the Gulf of Paria, Trinidad. They usually disappear to the caves which they inhabit at about half past five or day-break, and I have watched them time after time when out fishing at night or at early dawn."

About the only other wild mammals that we saw or heard of at Antigua were the mongoose and the "cane rat," both of which are regarded as "vermin."

There is but one snake on the Island and that one would be very easily mistaken for an earth-worm, which it greatly resembles in form, size, and color. It is doubtless a species of *Typhlops* or "blind worm." The head is not all differentiated from the body and is similar to the tail in form except in being somewhat blunt. The body is cylindrical throughout with none of the ventral flattening of other snakes. It is covered with small imbricating scales, those on the ventral surface not differing from

the others in size or shape, in which it offers a marked contrast to any other snake that I have ever seen. Its eyes are covered by the plates on the sides of the head (ocular plates, I suppose) which gives it the appearance of being blind. Hence the popular name of "blind worm." Those plates are translucent, however, and the eyes can be well seen through them. The specimen examined and described is 6 inches long. Miss Gertrude Van-Wagenen tells me that this species has the right lung only, the left being aborted.

Although a perfectly harmless creature, this little species is feared by the natives, who are afraid to handle it. Indeed Professor Thomas reports that a man who was helping him and Mr. Stoner collect insects could not be induced to remain in the vicinity of one of these *Typhlops*. This man, by the way, gave the interesting information that all of the other snakes in Antigua had been killed by the mongoose, and that the *Typhlops* was habitually produced by *spontaneous generation*.

There are several species of turtles. One is a land tortoise known as the "gopher," belonging, I suppose, to the genus *Testudo*. It is a very peculiar form, with the carapace highly arched and truncate behind. The plates have a central yellowish polygonal area surrounded by a very dark brown border consisting of numerous close-set parallel ridges conforming to the outline of the plates. The plastron, as well as the carapace, is very solid and heavy, the whole armature making an unusually solid box into which the head, feet, and tail can be completely retracted. The feet, particularly the hind ones, greatly resemble those of an elephant in form, but the soles are covered with heavy cobblestone-like rounded plates. There are five toes on the front feet and four on the hind. The nails are strong and considerably flattened.

This species differs from the "gopher" of Florida in several particulars, such as the shape of the front lobe of the plastron, and the absence of a nuchal shield. In general appearance it looks a good deal like a small edition of the gigantic land tortoise of the Galapagos Islands. It seems to be entirely terrestrial in habit and burrows deeply into the ground. The flesh is eaten by the natives, but we did not experiment with it. The

one above described has a carapace about nine inches long and five inches high, measured at the highest point which is considerably back of the middle.

Two species of marine turtles are commonly found here. One is the green turtle (*Chelonia mydas*) which is said at times to weigh as much at 800 pounds. Ordinarily, they are much smaller, probably averaging from 50 to 100 pounds. The flesh of the young specimens is excellent and so are the eggs. These turtles feed on the eel-grass in a rather shallow water, and are caught by nets stretched across the entrance to the bays which indent the coast.

The hawksbill (*Chelonia imbricata*) is usually smaller and has remarkably long fore-legs or flappers. The scales overlap and are longitudinally keeled. It seems that the smaller specimens are preferred for the tortoise-shell of commerce. The species is carnivorous and an expert swimmer, the best divers among the natives being unable to catch it in the water.

Fishes.—Perhaps the largest common edible fish at English Harbor was the Barracuda. A huge fellow was often seen cruising along the sea-wall. It was able to break any of the lines which were placed at our disposal by Mr. Collens, who, by the way, is an enthusiastic fisherman. An individual of this species was brought in by a local fisherman that looked as if it would weigh as much as 20 to 25 pounds. Under certain conditions it is said to be poisonous, and some of the natives are afraid to eat it. The writer has partaken freely in various parts of the West Indies and never felt any ill effects. The Barracuda is emphatically a gamy fish, takes the hook readily and affords excellent sport.

The red snapper (*Neomænis aya*) seemed to us to be the best table fish that we found here, being of good size and having firm white flesh of excellent flavor. Some large specimens were brought in by fishermen.

We secured a spotted moray under very exceptional circumstances. Albert was cleaning a large conch on the stone flagging which forms at one place an incline leading down to the water off the sea-wall. Suddenly the snake-like head of the moray appeared through a crack between the stones and the animal darted at Albert's toe, which was saved from injury only by a

quick jump on the part of the always agile diver. The moray retreated into the crack, but Albert, determined on revenge, got a short stout line and hook, baiting the latter with pieces of conch meat and dangled it in the crack. The moray promptly responded and *followed the hook out on to the flagging*, making quick jumps at the meat in a most voracious manner. It was the first time that we had seen a fish come ashore for its food and we were greatly impressed with its determination and utter fearlessness, being not at all deterred by the presence of several of the party who had gathered near to see the sport. Finally it made a successful grab and was firmly hooked and taken wriggling to the laboratory for preservation.

These morays seem to be quite local in their habitat. There was one big fellow that we saw lurking under a large rock on our favorite collecting ground near Rocky Point, and we were rather circumspect in approaching too near this particular rock, as these fish are capable of inflicting very troublesome wounds with their strong and exceedingly sharp teeth. Dr. David Starr Jordan once told me that certain natives of the Hawaiian Islands were able to dive and take the large morays of that region from their fastnesses in the rocks, using their bare hands only. This seems to me to require more bravery, as well as skill, than to attack a shark in its native element.

Perhaps the most interesting fishes that we secured at English Harbor were collected by the use of the electric light at night. The half-beak (*Hemirhamphus*) is a very bizarre creature, with a long snipe-like bill which appears to consist of the lower jaw only, the upper not being at all produced. The beak ends in a slight swelling that is yellowish by daylight but decidedly phosphorescent at night, a fact that I have not seen noted. These half-beaks were attracted in great numbers by the electric light and were easily taken in the dip-net. It is interesting to note that practically all of the fishes taken in this way were distinctly phosphorescent, there being evidently a sort of phototactic condition associated with the possession of light-producing organs. It was also noticeable that fishes that were thus attracted were as a rule very translucent or at least pallid,

without noticeable color markings except as they were associated with phosphorescent organs. Many of them, however, had a silvery sheen.

This translucency is carried to the extreme in the case of the so-called "ghost fishes" which were also caught in abundance by means of the electric light. These are the young of certain eels and are ribbon-like in form, being extremely compressed and three to four inches long. Their most remarkable peculiarity, however, is their extreme translucency while in the water. Even when there were numerous specimens in a glass dish, we could not see, but had to feel for them. When out of the water, however, they are not translucent, but pallid.

Another interesting form secured in this way is probably one of the "snake-eels," small, very slender, worm-like creatures that fairly swarmed about the electric light and were taken in great numbers in the dip-net. A small fish shaped like a pumpkin seed was remarkable for the size and number of its phosphorescent organs that were seen to be brightly luminous as these fishes swam around and approached the light. It seems to be characteristic of forms that are attracted by the electric light that they have proportionally large conspicuous eyes which are often almost black in color.

The fishermen here use fish-pots that are smaller and seem to be less skillfully constructed than those at Barbados. Another method is to use large seines set across some channel such as that at the entrance to English Harbor. When the net was to be hauled, a large boat propelled by oars came from the town of Falmouth loaded down to the gunwale with men, women and children, the latter in every degree of undress. Everyone took hold of the lines and helped to haul in the huge net. It was certainly a lively scene, as all were wildly excited and there was much yelling and dancing around, especially when a big tarpon appeared in the net and flung itself savagely in all directions, finally succeeding in making its escape amid the lamentations of the cruelly disappointed blacks.

A style of boat is used here that I have never seen elsewhere. It is made of "may-poles," which are the great central flowering stems of the century plant, perfectly cylindrical and wonderfully light and buoyant, being filled with pith which the natives

sometimes cut into strips and use as razor strops. A number of sections of these may-poles are lashed together to form a raft with sides and ends made in the same way. The box-like boat is about ten feet long and four broad, is exceedingly light and can be paddled at a very respectable rate. We saw it in use only in the protected waters of the bays, but were told that the natives sometimes venture out even on the windward coast in this seemingly frail craft.

*Crustacea.*¹—Here as at Barbados the largest crustacean was the “crayfish,” or *Palinurus*, some of which were brought in by fishermen. Aside from this, there were no large macrurans, the species secured being small, shrimp-like forms, usually obtained by overturning or breaking up rocks, particularly coral rocks. Among these may be noted *Stenopus semilævis*, var. *martens*, with an orbicular carapace about as wide as long. It was bright red, the two chelæ being nearly of the same size. A spiny ridge originates near the base of the rostrum and runs backward along the median line of the carapace. The eyes are nearly sessile and quite unusual in color, being bright red with jet black centers like the pupils of vertebrates. The antennules are, as usual, bifid and very attenuate, while the antennæ are long, closely annulated and armed with short setæ. There was also a shrimp-like form with a pinkish back. The swimmerets were ornamented with very fine tufts of exceedingly delicate hairs. A shrimp, *Metapeneus goodei*, collected by the use of the electric light, was colorless, as were indeed nearly all of these nocturnal creatures that are attracted by artificial light, and had relatively enormous jet-black eyes. The squame of the antenna was a marvellous structure, very delicate, translucent, and with a comb-like fringe of perfectly parallel and extremely fine hairs. The surface of the scale was beset with rigid, bristle-like hairs, hooked at their ends, and with small ring-like insertions. These were doubtless sensory structures.

Several forms related to the “pistol crabs” were secured. One, *Crangon armillatus*, was nearly two inches long, the carapace being ornamented with conspicuous red bands, while the

¹Dr. Mary J. Rathbun has kindly identified most of the crustacea mentioned below. Any mistakes are to be ascribed to the author.

chelæ were mottled with white on a red background, and finely haired. The "finger" was very short and stout, and curved like a parrot's beak, and the tips of the chelæ were crossed when closed like the mandibles of the cross-bill. Another was very conspicuously colored, being bright blue and dark red with antennæ ringed with red and white. This is the form before mentioned that lurked under the tentacles of an anemone. I became aware of its presence when trying to detach an anemone from a stone, when I received several rather sharp thumps on the end of my finger causing a quick withdrawal of the hand. The sensation was most peculiar, somewhat like receiving an unexpected electric shock. Upon further examination and experiment, I found that these peculiar thumps were due to blows from the large chela of this pistol crab, which were being projected forcibly forward, hitting my finger-tip with the end of the closed chela. At the same time the animal recoiled, but it would not leave the vicinity of the anemone, which, by the way, was armed by unusually large nematocysts and had conspicuously annulated tentacles. It occurred to me that the unusual color of the antennæ of the crab, annulated red and white, was for the purpose of simulating the appearance of the tentacles of the anemone, thus forming a very good example of protective mimicry. Miss Van Wagenen tells me that she had a similar experience with the same species of crab and anemone. Although I have seen several cases in which there was a commensal relationship between brachyuran crabs and anemones, this is the first time I have found a macruran involved.

Several species of mantis shrimps allied to *Squilla* were found. One, *Gonodactylus cerstedii*, was small and had a beautifully ciliated antenna-squame, as well as the pleura of the abdominal segments. The carapace and dorsal surface of the abdomen were ornamented with fine round black dots. A bright reddish shrimp-like crustacean was carrying a surprisingly large mass of bright red ova and its eyes were covered by a transparent scale-like projection from the carapace. Why the ova should be so brilliantly colored in so many crustaceans is more than I can explain. Perhaps in this case it is to match the color of the bearer. Another small macruran is quite robust in form, its head having a lateral profile reminding one of a miniature pig. The carapace

has a median crest of angular projections running forward to the rostrum, and its cephalic part is beset with a number of thorny points projecting forward.

Among the anomurans are several kinds of hermit crabs. One of these *Paguristes grayi*, has the dorsal surface of the carapace and of the exposed appendages colored a very rich crimson, maculated with sharply defined white spots which are round like polka-dots. The chelæ are strongly barred, and the two are nearly alike in size. Another hermit is quite small, but the left chela is much enlarged, turgid, with a relatively short finger. The hand has a very conspicuous bright blue area on an almost white background. The other exposed appendages are light yellow with distinct black polka dots.

Brachyura.—The common "fiddler" crab appears to be *Uca leptostyla*, agreeing well with the excellent figures given by Miss Rathbun in her "Grapsoid Crabs of America," which by the way, is an extremely useful work for those who wish to identify these very numerous crustaceans. This "fiddler" is very common on some mud-flats bordered by mangrove swamps back of English Harbor. There is something irresistibly comic in these creatures as they raise their preposterously large chelæ in front of them like boxers squaring off for a bout. It seems to be largely a matter of "putting up a bluff" however, although they can pinch with a vengeance when cornered. I imagine that these chelæ are proportionately among the largest found among the crustacea, and the relation of the width to length of the carapace is also very exceptional. The chelæ can very easily be cast off, thus enabling the animal to escape by leaving its weapons in the hands of the enemy. The manner in which these creatures wave their eye-stalks around at times gives them an exceedingly knowing and wary appearance. Their eyesight must be particularly good, as they scuttle away in a regular wave before the human intruder has approached within fifteen or twenty feet, and sidle along so nimbly that it is by no means easy to secure them before they pop sidewise into their holes in the mud to issue out again promptly after the danger has passed. I saw no fiddlers on the sand beaches at Antigua, where they seem to prefer the mud flats.

The largest and to me the most interesting brachyuran that we

found at English Harbor was the hairy-legged land-crab (*Ucides cordatus*) which lives in the mud in the mangrove swamps not far from Clarence House. This grotesque crustacean has a spread of as much as fifteen inches. The carapace is colored a rather bright orange brown above, the chelæ are conspicuous purple and white, and the walking legs a dark purplish red with long fringes of coarse hairs. The chelæ are enormous. In going by this swamp one day I saw several specimens and succeeded, after some difficulty, in securing one. The next day I went to the same place with Albert and was lost in admiration at his dexterity, already referred to, in securing a bagful in the course of a half hour. I could not for the life of me understand how he could catch three of them in rapid succession and hold them, a mass of slimy mud, wildly waving chelæ and hairy legs. I could comprehend his catching one in each hand, although that in itself was a difficult achievement; but how he could hold two and still capture a third was beyond my comprehension. He did not come out of the encounter unscathed, as he remarked, "They bites hard, suh!" Strangely enough, although several subsequent attempts were made by Albert, neither he nor anyone else was able to secure another specimen after that first big haul. The mangroves grow on a mudflat that is inundated at practically every high tide. These big crabs burrow some distance in the oozy mud; issuing from their burrows at low tide and crawling among the mangrove roots. Albert's method of catching them was to make a quick rush and put a spade into the mud some distance behind their hole, run his hand and arm into the burrow till the crab was backed up against the spade, grasp the big claw and carapace at the same time and then haul him out. Later he discarded the spade and used one hand instead. A nastier wriggling mass of slimy mud and great hairy spider-like legs I never saw. The writer simply "held the bag" and not for the first time in his experience. The bag was an old rotten gunnysack that kept breaking through in spots, which rendered the job no sinecure, but we got them all safely to the laboratory.

Having demonstrated the contrivance for aerial respiration as shown by another species of land crab, *Gecarcinus* (See Narrative of the Bahama Expedition, page 97), I found it exceed-

ingly interesting to make a similar investigation regarding the respiratory apparatus of this species, *Ucides cordatus*. The branchial chamber is tumid and the walls rather thin. It is lined by a membrane that is smooth to the touch and feels as if oiled. That portion which lines the dorsal part of the chamber is dark colored and seems covered with short tufts of villi. Holding it up to the light it shows the impression of branching channels or sinuses resembling the markings on the inside of the human parietal bone. These sinuses appear to be between the membrane and the part of the carapace which it lines. The branchial chamber is partly divided into moieties by a shelf-like projection from the branchiostegite. All of the gills are below this shelf and are packed away horizontally in the lower part of the chamber, leaving the upper part quite empty. This arrangement differs from any other that I have seen.

The wall bounding the branchial chamber on its inner side is rather delicate, membranous, and highly vascular. This is the body wall proper, dividing the branchial chamber from the real body cavity. Projecting from this wall, against which it is applied in an approximately horizontal position, is a strange structure entirely new to me. It is a tumid, bulging, somewhat S-shaped body, light in color and with rather thick walls. It is tubular in structure, but the tube diminishes greatly in diameter at each end, opens posteriorly into the body cavity and anteriorly it seems to lead into a space in the suborbital plate just beneath the eyes, whence issues a large branching vessel applied to the lining of the upper part of the branchial chamber as already described. The lumen of the tube was filled with what appeared to be dried blood, although this interpretation may not be correct. Below the anterior concavity of the S-shaped body referred to, and attached to the branchial side of the body wall proper (which is here very thin and transparent) is a group of stiff slender projections which are tumid and usually clavate at their distal ends. They feel like cartilaginous structures and project stiffly into the branchial chamber. There are six or seven of these curious projecting rods, some much longer than others. I have no idea as to their function, and find no reference to them in the literature at hand. One gets the idea

that they may be sensory perhaps with a function similar to that of the osphradia of certain mollusks.

It seems evident that this upper portion of the branchial chamber is modified for the purpose of breathing air, the high vascularity of the limiting membrane and the villi-like tufts in the dorsal portion being almost certainly for this purpose. The conspicuous S-shaped tube may be really an immense sinus in lieu of a branchial blood vessel, opening into the body cavity not far from the heart. The gills proper occupy the lower part of the branchial cavity, being packed away just below the shelf-like process from the branchiostegite, and lying in a horizontal plane; the upper edges of the very numerous gill-plates forming a sort of paving to the upper part of the chamber. Resting just on these upturned edges of the gill lamellæ is a much flattened thin chitinous blade-like plate with its edges fringed with long hairs greatly extending the surface of the plate. It reaches the entire length of the chamber and its anterior end is attached to the base apparently of the second maxilla which, by its movement, causes the plate to sweep back and forth over the upturned edges of the gill lamellæ. The whole structure is in fact a modified scaphognathite, a delicate brush which applies water to the surface of the gill plates. The gills themselves, six in number, are not attached to the walking legs as in many decapods, but to the floor of the branchial chamber just above the bases of the legs. Thus the movement of the gills within the chamber characteristic of many crustaceans is not possible here. Instead of this, it seems evident that the water is brushed over the gills by the blade-like structure just described. Upon lifting up the gills it is seen that there is a similar brush-like plate, more strongly bent in a horizontal plane, and with perhaps a fringe of longer hairs, attached to the base of the third maxilliped which by its movements sweeps this delicate brush over the lower edges of the gill lamellæ. Thus these two brushes apply the water to both the upper and lower edges of the numerous gill-plates, which are themselves stationary. A very thick matting of hair is found at the base of the third maxilliped near where the brush-like blade is attached. Still a third, but very much smaller, brush is found under the most anterior gill, which is tucked away beneath the S-shaped tube and against the

inner wall of the branchial chamber. The under surfaces or edges of the lamellæ of this gill are brushed by this third blade, which is, I suppose, attached to the first maxilla, although the condition of the specimen was such that this point could not be satisfactorily determined.

This method of applying water to the gills is evidently the same as described by me as found in *Gecarcinus*; but in that case the brushes were not so flat, more like bottle-brushes in fact, and the gills themselves more completely filled the branchial chamber.

It would seem that the respiratory arrangement in *Ucides* is still more highly specialized than in *Gecarcinus* in that a definite portion is set apart and specialized for air-breathing, while aquatic respiration is effected much as in the last species. *Ucides*, it should be remembered, lives in the water when the mud-flats are submerged; and on the mud, where aerial respiration would be extremely useful, when the tide is out. Thus it has in effect a double set of respiratory organs analogous, but not of course homologous, to those of such an amphibious vertebrate as *Necturus*. This arrangement is in fact an intermediate stage between that of *Gecarcinus*, which spends a good deal of time on land, but depends on a modified gill respiration; and that of *Birgus latro* which is almost wholly terrestrial and depends upon an entirely different respiratory apparatus which closely resembles lungs, having but a vestige of gills left in the bottom of the branchial chamber.

Another land-crab secured on the mud-flats has the carapace light blue, almost sky-blue, and the legs purple. It was very active and aggressive.

A much flattened form, allied to *Sesarma*, had orbicular chelæ with short stubby fingers and a serrate row of spines on the anterior edge of the merus of each walking leg. A most peculiar little species, a *Petrolisthes*, was almost carmine and characterized by much flattened chelæ, the anterior edge of which was almost like a knife-blade. Its most unusual feature, however, was the antenna, which was very long and filiform and finely annulated throughout. This is the only brachyuran crab with antennæ resembling those of the macrurans collected by the

Barbados-Antigua expedition. The squame of the antenna, however, seems absent.

Of course there were almost innumerable instances of camouflage among the small crabs secured in the tide-pools and by pounding up pieces of rock. Many bore sponges on their backs, or were hairy or mossy in appearance. Some were dark green like the vegetable growths among which they lived. Others resembled corallines. One little crab (*Thoe puella*) is carmine pink with very conspicuous irregular blotches of white on the carapace and legs. It is probably camouflaged to resemble a coralline covered with an irregular incrustation of white Bryozoa. The entire surface is packed with smooth hemispherical tubercles. The chelæ are relatively small, slender and of equal size. The walking legs have the merus greatly flattened and hollowed on one side so as to make a pocket which resembles that of tibiae of humble bees for carrying pollen. The legs bristle with spines, hairs, etc., so that the creature reminds one of some of the mites, greatly magnified, of course.

There were many, however, that were notably conspicuous in color, vivid reds predominating. These could not be protectively colored, as red is usually absent in their environment or at least not common. I remember one quite flat species that was a very dark olive, but the chelæ were sharply marked with lines of brightest yellow. Here, as at Barbados, the chelæ seemed the seat of the brightest ornamentation. It may be that this in a way serves the purpose of warning coloration among land forms such as wasps and bees, calling attention to their weapons, as it were. One little crab was quite pale in color, but the fingers were jet black. Some species common at Barbados, *e. g.* *Cardisoma*, or red land-crab and the triangular *Leptopodia sagittaria* were not seen at all at Antigua.

Echinodermata.—Here, as at Barbados, the paucity of starfish was remarkable. With the exception of a few minute forms, the only species found was the widely distributed West Indian *Oreaster reticulatus*. Mr. Greenlaw found a place in Falmouth Harbor where these were fairly abundant, and collected a number of specimens for laboratory use. This is the species most frequently encountered in curio stores in Florida and elsewhere.

It is a fine form for laboratory study and furnishes excellent material for research in the line of individual variation. The colors here, however, are not so vivid as we found them in the Bahamas, dark red predominating.

Many of the sea-urchins collected were of the same species as were found at Barbados. The white sea urchin, *Hipponoe esculenta* (or *Tripneustes esculentus*, according to Clark in his "Crinoidea and Echinoidea of the Bahama Expedition"), is found on muddy bottom in Falmouth Harbor. Dr. Clark does not give us any clue to his reason for abandoning the familiar generic name *Hipponoe* for this form. It was used by Agassiz in 1872 and has become firmly established in the literature of the Echini. Clark cites the name *Tripneustes esculentus* as used by Bell in 1879, which does not indicate a priority for that name. The writer believes it is preferable in the present work to use the names familiar to the general zoologist, even when priority has been proven for some other name.

This species does not seem to be in general use as food at Antigua. While not so abundant as at Barbados, there are places where it is quite common and could doubtless be secured in sufficient quantities to be of considerable importance in times of food scarcity such as are by no means unknown in Antigua. In the mud-flats it is almost invariably covered with eel-grass, small stones or shell, which seem to be placed there by the animals themselves for purposes of concealment. Here again we find the two forms of this species already referred to. One form is entirely white, while the other appears to be black with white spines. The black color is due to innumerable black-headed pedicellariæ packed in between the spines so thickly as to give an impression that the test itself is black. It seems that this is neither a sexual nor seasonal difference, both sexes being found in the same form and at the same time. It may be that we here have a kind of dichromatism among the Echini such as is found not infrequently among birds, *e. g.* the common screech-owl, and of which I have seen no adequate explanation. It hardly seems likely that two species so nearly alike would constantly occur in close association. They are found in very shallow water in Falmouth Harbor. Indeed, they are often in

water not more than a foot deep and on soft mud. At Barbados they are in deeper water and on sandy bottom.

The all too familiar black sea-egg *Diadema antillarum* is abundant here, as it is everywhere that I have collected in the West Indies. Several had established themselves on the stone steps leading down to the bathing place at the Dockyard. Another well-known species had the same habitat as the *Hipponoe*. This is *Toxopneustes variegatus*. This was found in abundance in Willoughby Bay and Falmouth Harbor. It resorted to the same method of concealment so generally adopted by its confrère, *e. g.* covering itself with debris of various sorts such as bits of eelgrass, small stones, shell, and even sand when it is available.

One cannot help wondering whether there is any conscious intention connected with such proceedings. The writer has shown elsewhere¹ that the white sea-egg has something that may be called memory, and the question arises as to whether certain Echini may not have the power of changing their habits, or as Jennings calls it, "modifiability of behavior," in view of their past experiences. Such a power would certainly be of use to the species and encouraged and perfected by natural selection. Of course this could conceivably occur without any conscious adaptation of means to ends and in all probability does so occur.

Another explanation of this habit occurs to me. These forms are on mud-flats in shallow water which is unusually still and warm under the tropical sun. May it not be that this covering of foreign objects affords a sense of relief such as that experienced by carrying an umbrella in the sun. In other words, may not the habit be for the purpose, whether conscious or not, of securing a shade to mitigate the heat of the sun, which we know is unusually severe on these mud shallows?

Another very common sea-urchin at Antigua is an *Echinometra* which I take to be *E. lucunter* or *E. subangularis* of Agassiz. In his "Revision of the Echini" he says that *E. viridis* has a "prominent bare abactinal system," while the present species has the system beset with spines. This species is extremely abundant on rocky bottom near the Pillars of Hercules and also under rocks² at Rocky Point. Right at the base of the high

¹Narrative of Bahama Expedition, 1895, p. 314.

sandstone cliffs which constitute the "Pillars" there is an almost level bed of hard rock over which the breakers surge at high tide and occasionally even at low tide. This rocky ledge has a number of cracks or fissures, and in these *Echinometra* fastens itself firmly to withstand the sweep of the waves. It is surprising how tightly these urchins wedge themselves and how hard it is to dislodge them. The species is quite variable in color and the actinal surfaces are often brilliant red, almost crimson, and their spines dull terracotta. Generally, however, the spines are purplish black, or sometimes dark green. They seem to prefer shade to sunlight and are often found under stones, where they share quarters with the equally abundant serpent star, *Ophiocoma echinata*. *Cidaris tribuloides* is another species found here but it appears to be rare; there is but a single specimen in our collection.

We were much interested in two species of spatangoids which are common here, although one must know where to find them. After we learned their ways and manners, we secured a good series of each. They were most abundant at the place which we called Rocky Point, opposite Fort Barclay. The ground here is strewn with waterworn rocks, many of them quite flat. An area was stripped of these rocks and the sand beneath them exposed. Then with our hands we dug down six to ten inches in the sand and found petalostichans singly or in small groups of three to five. We never found living specimens on the surface of the sand nor even just beneath the surface, but always at the depth mentioned. These flats are covered with water at high tide, but even when so covered we never saw these curious Echini, although we collected there several times when the tide was in.

The question obtrudes itself,—on what do these creatures feed? One would not expect to find much nutriment under a layer of six to ten inches of almost pure sand, nor would he expect to find organic matter in any quantity under an effective sand-filter such as this. In order to answer this question, the writer has examined the contents of the intestinal tract of some of these spatangoids and finds it filled with what looks like pure sand with broken bits of shell, coral, sea urchin spines, etc. A closer examination, however, discloses a number of Foraminifera, which, from their fresh appearance, were alive when de-

voured by the urchins. It seems evident, therefore, that these Protozoa furnish a considerable portion of the nutriment which sustains the life of these burrowing sea-urchins. It was a surprise to me, however, to find this apparent proof that these delicate protozoans could live under this firmly compacted layer of sand, and we are still confronted with the question,—what do *they* live on, under an almost ideal sand-filter? This sand is almost entirely calcareous and thus furnishes an abundance of the carbonate of lime which contributes perhaps ninety per cent of the material of which these sea-urchins are made. Of course it may be said that they live on the sarcode from other protozoa, or even disintegrating members of their own kind, all of which reminds one of the celebrated commercial enterprise known as the "Cat and Rat Farm," the owners of which were said to be realizing huge profits by feeding the rats to the cats, skinning the latter, disposing of the pelts for cash and then feeding the bodies of the defunct cats to the rats, and so *ad infinitum*.

Possibly, these urchins are nocturnal and come to the surface to feed in darkness. In that case the difficulties discussed above will disappear.

There were, as already indicated, two species of the curious forms. One was apparently *Echineis semilunaris*, which was also secured at Barbados. It was smaller than the other, but much like it in shape and color. The test is ovoid and the ambulacra are not at all sunken, but each appears as a perfectly evident double line of pores extending almost parallel around the test to the actinal surface. The mouth and anus were close together and both ventral. The tests were exceedingly fragile and had to be packed carefully in cotton for transportation.

The other species agrees very well with the excellent photographs and description of *Brissus unicolor* found in Alexander Agassiz's splendid monograph "Revision of the Echini." Although more recent writers may shuffle the names *ad libitum*, it is doubtful if any better work will be done on this group than is found here. The specimens collected by us at Antigua were none of them so large as those figured by Agassiz; but they agreed very closely in detail. A typical one is ovoid in form, the posterior end somewhat elevated and truncate. It is 5.3 cm, in length, 3.8 cm. in diameter, and 3.2 cm. in height. The

color is uniform hair-brown the mouth is considerably in front of the center of the ventral surface and the anus is quite large and high up on the posterior truncated end. There are four genital pores and the ambulacral rosette is slightly sunken, but the anterior petal is almost obliterated and disappears on the ventral side of the animal. The peripetalous fasciole is quite evident and forms re-entrant angles between the petals. The anal fasciole and plastron are plainly seen and the latter is relatively large. The tubercles on the ventral plastron are not notably larger than those found elsewhere. The delicate spines which are borne on the fascioles are compactly arranged and erect like a close fence. There are three kinds of pedicellariæ, all three-pronged. The largest kind has very slender, much-curved prongs, each of which describes nearly a perfect semicircle from base to tip, the three together enclosing a spherical space. The other two are much like those of ordinary sea-urchins, being pyriform in shape and differing mainly in the fact that one kind is borne on a relatively long stalk, while the other is nearly sessile.

On opening a specimen, the intestine was found to be coiled like a watchspring, making a little more than two complete revolutions. In life the ambulacral feet are extended at times considerably in advance of the spines, and are provided with suckers.

Ophiuroidea.—The serpent stars were numerous although, on account of being unable to dredge successfully in relatively deep water, it is probable that not so many novelties were secured here as at Barbados. At both places *Ophiocoma echinata* was by far the most abundant form and wriggled out from almost every overturned stone. The variations in color were exceedingly great and would form an interesting study. One of the most common disk markings was a pentagonal cream colored area on the disk, sharply outlined against a dark umber brown background. Some specimens have a spread of more than a foot. From the wide distribution of this species in the West Indies and its excessive abundance in shallow water, it has evidently attained a marked success in the struggle for existence. It would be exceedingly interesting to know just what character

or conjunction of characters has determined the success of this, as well as of many other species of Echinoderms, *e. g. Diadema antillarum*.

Ophiocoma riisei is a species that greatly resembles the last, *O. echinata*, and is found associated with it although not nearly so abundant. It differs from *O. echinata* in having one tentacle-scale instead of two and having the upper arm-spine much longer than the others. Another *Ophiocoma* has greenish yellow arms banded with brown. It was abundant in the same region with the others, but seems quite a distinct form. *Ophiocereis reticulata* has the disk marked with an open reticulation of reddish brown lines, three arm-spines, and supplementary arm-plates. It bears a very close superficial resemblance to the *Ophiocoma* just mentioned, so close that it looks like a case of camouflage. The genus *Ophiolepis* is represented by a species with the disk covered with rounded scales surrounded by smaller ones. The side mouth-shields are very large and almost touch each other. There are many representatives of *Ophiura* greatly differing in color, but all having the four genital slits characteristic of the genus. Many are doubtless the familiar *O. cinerea*. One form is very dark olivaceous green, almost black, while some young specimens have very distinct but distant arm-bands of dark greenish. A single specimen of *Ophiomyxa flaccida* was secured.

Holothurians.—Dr. Fisher found a number of species of this group and will officially report on them. He has kindly given me the names of those mentioned below and also some comments which I incorporate.

Stichopus möbii is a large heavy species often reddish brown and with an exceedingly tough integument. I understand that this is the form commercially known, when dried, as "trepang" in Oriental countries. It is quite abundant in English Harbor and Falmouth Harbor. Dr. Fisher said that he found this the most difficult to kill extended of all the holothurians collected, "as the mechanical contraction of the heavily muscled body wall would force out the viscera even after the creature was apparently dead." He also says that these heavily muscled or thick-walled holothurians "are the ones most given to dispensing

with their internal fittings on slight provocation." The intestines were filled with the sandy mud of the eelgrass bottoms.

Euapta lappa (Müller) is in many respects the most interesting holothurian that the writer has ever seen. A fully extended specimen sometimes reaches the length of two feet and looks more like an enormous worm than anything else. It is quite translucent, being thinner walled than most species, and the body is longitudinally striped with reddish brown bands and bears numerous rounded nodules arranged in annular series; but these disappear completely when the animal is entirely extended, or in parts of its length which are extended, only to reappear instantly upon contraction. Waves of such contraction pass rhythmically along its length. It is the most active holothurian by far that I have ever seen and is really a beautiful object when in the aquaria and in vigorous motion. The feathery tentacles are in constant activity, waving this way and that, lengthening and shortening, bending gracefully, their frilled edges a constant play of activity; while the whole body is in rhythmical movement, bending, twisting, elongating, retracting, and at the same time pulsating with the waves of retraction already referred to, during which the hemispherical nodules appear and disappear as if by magic along its whole length. The transparency of the body walls gives a peculiar delicacy that we do not usually associate with the ordinarily unattractive "sea cucumbers." Mr. Ricker took a movie of one of these animals in action that will doubtless prove of unusual interest.

These creatures belong to the apodous group, being devoid of the ambulacral feet characteristic of most of the more familiar forms. Strangely enough, although footless, it moves with much more freedom and speed than its heavier relatives. It was found commonly in shallow water, often lurking under rocks associated with sea-urchins and serpent stars.

Its footless condition is compensated for by the possession of several peculiar features. Doubtless the hemispherical and temporary nodules already referred to give it a hold on the stones between which it worms its way, and its extreme distensibility enables it to go through quite narrow holes and cracks, while the waves of contraction serve to push it rapidly along either on

the surface of the sand bottom or over and between rocks. It can also swim to a limited extent and will frequently raise itself on end in the aquaria so as to assume a vertical position with the tentacles exploring the surface while the aboral end rests on the bottom.

This creature has a peculiar sticky feel as if covered with an adhesive substance. This is due to the very remarkable and beautiful spicules found in enormous numbers embedded in the body walls. These are of three kinds:— First are the “anchors,” beautiful representatives of the anchor of a ship, although quite minute, and looking as if made of glass. The general outline is perfect, except that the symmetrical hooks are devoid of flukes near their ends. The shank narrows gradually from the hooks to the basal end, which bears two opposite miniature hooks armed with a few nodules on their outer faces.

The second kind of spicules is the “anchor plate.” These are flat plaques, oval in shape with one end suddenly narrowed into a smaller disk-shaped body. These plates are about two-thirds as long as the anchors. The main body is perforated by usually seven oval spaces, the inner edges of which bear fine denticles like the inside cogs of a wheel. The small disk-like extension at one side is like a very fine piece of fret-saw work, appearing to be very much more delicate in structure than the main body. When seen embedded in the integument, each anchor looks as if it were enclosed in a delicate sack and stands with the hooks up. Their very tips, however, appear to project from the investing sack, and doubtless it is these minute sharp points of the anchors that give the adhesive feel to the integument of the live specimen, and the “sandy” feel to preserved ones. The end of the shank opposite the hooks is attached by what appears to be ligaments or muscles to the smaller disk-like ends of anchor plates, although the two sorts of spicules do not seem to be in actual contact. The anchor plates are embedded more deeply in the integument than the anchors, and lie in a horizontal position, thus giving a very fine anchorage to the anchors themselves.

The third sort of spicules is much smaller and in the form of minute rosettes, being about half the diameter of one of the holes in the anchor plates. They are made up of very fine nodules of calcareous matter, looking like small lozenges encrusted

with beads. I was unable to make out any regular relation in position between these and the other sorts of calcareous spicules.

All this seems to be rather an elaborate set of contrivances merely to give a roughness to the surface which enables the animal to secure a purchase on the bottom over which it crawls; but it certainly "does the business," as any one who has watched them when alive can testify. I suppose nature has plenty of time at her disposal and it almost seems that at times she gives an almost needless finish or daintiness to her work as if she did it for the sake of turning out a fine piece of handicraft. This thought has often been almost subconsciously in the writer's mind while studying the wonderfully beautiful and intricate patterns of the spicules of the gorgonians "each after its own kind," or the elegant chalices of the campanularian hydroids. So often it appears that there is a lavishness of dainty patterns far in excess of purely utilitarian ends, that it seems as if nature or some sentient creative power did it "for His own pleasure."

But this is all moonshine of course and not at all scientific, more akin indeed to the iridescent dreams of the poet than the sane conceptions of the systematic zoologist, but even he must break over the traces at times and give the rein to fancy.

The following notes are quoted *verbatim* from Dr. Fisher.

Holothuria surinamensis Ludwig. A very sluggish species found under rocks at English Harbor Point, on the sheltered or bay side close to the place where the mauve *Porites* was very common. This form was living in such a way that the body was surrounded by stones, or sometimes but not always, by stones and sand. We always found them in a few inches of water and not totally uncovered as at Barbados. In the aquaria this species was fairly active, but not nearly so much so as the big synaptid *Euapta*. The water in which they live is very shallow and becomes quite warm from the sun at low tide when there is no circulation. From this species two kinds of *Fierasfer* were recovered. These came out in a jar in which four or five holothurians (all of this species) were being narcotized with $MgSO_4$.

Holothuria mexicana. A large, very dark brown, almost black species with small pedicels and papillæ which was very

common in the eel-grass of Falmouth Harbor along with *Diadema*, *Toxopneustes variegatus*, and *Tripneustes esculentus*. In this shallow water, which became quite warm at noon, were quantities of *Manicina*, and curiously enough, *Millepora alcorni* of the most branched form. The animals are superlatively sluggish in daytime. The bottom upon which they live is of very fine sand or mud, often slimy with organic matter, and the fine particles adhere to the skin of the holothurians, giving them sometimes a dusky hue. A form of this species, or possibly a distinct species, has a vermilion pink ventral surface. In the aquaria at night the animals were more active than in the same situation during the day.

The alimentary canal of a number of failures at anæsthetizing—to-wit, of specimens which eviscerated— was full of the fine silt of the Harbor, but this was true of all species. I watched these animals in their native haunts and I failed to find one crawling about.. All seemed to maintain a peevish reserve, due, I think, to the irritating effects of the brilliant light.

Holothuria captiva Ludwig. A small brown, very warty species about $1\frac{1}{2}$ to $2\frac{1}{2}$ inches long, found abundantly under stones at Harbor Point in the same locality as *H. surinamensis*, and very sparingly under stones at Falmouth Harbor. It has bright yellow tentacles and shoots out the delicate viscid Cuvierian organs with great freedom and precision. It was the only species that did this trick. This form was very active in captivity. It is found under rocks that rest against rocks, rather than the sand; and the water, again, is very perceptibly heated when the tide is out. A small spider crab which was "shot up" with the Cuvierian filaments, was visibly embarrassed as the threads stretched out at each movement of his legs. He solved the difficulty, however, by eating the threads.

Holothuria glaberrima Selenka. A very dark brown, almost black species, with large, practically dendritic tentacles and a mass of small crowded tube-feet, as many as the ventral surface will hold. This species is found only on the rocky shores exposed to the buffeting surges of the open sea. It lives in miniature basins of the rocks associated with *Echinometra lucunter*. These little hollows seem to be the "forms" once occupied by *Echinometra*. When the tide is out, the hollows retain usually

a little water, which is replenished with air-charged foamy brine each time a breaker cascades back into the sea. I noticed that the tentacles are kept expanded in such little pools and I thought at first on account of their large size that the animals were one of the Cucumariidæ. In hollows of sufficient size, several animals were wedged tightly together after the manner of the tiny *Cucumaria curvata* of the Monterey region. They are difficult to dislodge, and it is easy to see how the unusual number of tube-feet aid the animal in clinging when the clawing waves can erode away cliffs. There is usually a plentiful growth of short tough kelp where these holothurians live. This kelp overhangs the edges of the little basins in which two or three of the animals are domiciled in such a way as practically to hide them in some cases. Animals five to seven inches long. A color variation: clear dark warm brown.

Holothuria rigida Selenka. Under the rocks which rested in the sand of Falmouth Harbor and which were never uncovered by the tide this sluggish species lives. Possibly it comes out at night, but was deeply buried in the day and not many were found. Sand-colored, with a row of brownish spots along the back and a rusty patch or stain on the whitish ventral surface; dorsal papillæ sparse and slender; tentacles small, white. In the aquarium it was very sluggish, both by night and by day. It is covered with sand grains all over.

Holothuria surinamensis—(variety). A slender, brown, yellow-tentacled species, exceedingly common at Falmouth Harbor in shallow water, where it fairly swarms among corallines and under stones in the eel-grass area. It is found where the water has receded at low tide, and hence is very tolerant to heat and exposure generally, and owing to its tough constitution is more difficult to kill with narcotizing reagents than any other species except *Stichopus möbii*. In life the animals are usually stained with a coating of fine silt or mud which adheres to their skin and partly obscures the rich brown coloring, upon which are marbling and spots of dark brown. The papillæ are rather prominent, unequal, and pointed. In aquaria they are rather restless. The shallow water in which they occur becomes very warm at mid-day and sometimes the animals are washed up on the beach or rolled around the edge, kept in motion by a ripple.

It is not evident what dislodges such animals, as they are always alive; possibly the incoming tide. We found them fairly swarming in certain favorable areas among corallines, which they like very much, especially the prevalent erect tufted or branched corallines. But they are even commoner under rocks, sometimes associated with the "sea centipede," the abominable polychæt with cactus-like setæ, and several species of ophiurians. They are from three to eight inches in length.

Holothuria grisea. A species whose predominating color is Indian red, marked off into patterns by dull greyish green spots, and with two longitudinal dorsal rows of dark reddish brown spots. Papillæ prominent; tentacles medium sized, yellowish with brown ends. This form is found under rocks just below high tide, and is apparently nocturnal. It is usually soiled by mud so that one has to scrub it more or less to get the bright colors. Its wart-like pointed papillæ are conspicuous. This form is very sluggish in the daytime, especially when the tide is out, but rather restless at night when in the aquaria; active for a genus which is never given to roving. I found one or two in the eel-grass in very shallow water in English Harbor, along with *Stichopus möbii*.

Mollusca.—The following notes are furnished by Mr. Henderson and are here repeated almost *verbatim*.

The shore-station conditions in Antigua are very different from those at Barbados. In the former are many bays from the partially to the wholly protected kinds, within which the quiet warm waters, muddy bottom, and stretches of mangrove shores offer types of environment not existing at Barbados. We did not, however, find the floor of either English Harbor or the adjoining Falmouth Harbor very productive. A few common and widely distributed small bivalves and the usual assortment of *Bullina*, *Cerithium* and *Modulus* appear to be the sole molluscan inhabitants of English Harbor, save upon the sea-wall of the old Navy Station and among the rocky debris of a coral reef at the harbor entrance. Living on the wall mentioned we found a remarkable colony of the very beautiful *Murex brevifrons* Lam. We took about two hundred of them in a space of fifty to sixty yards. This particular *Murex* is scarcely to be distinguished from certain Indo-Pacific forms and is one of the really fine

species of that aristocratic genus. On account of its similarity to certain Pacific species, its synonymy in literature is long and confused.

Although its geographical range is a wide one (Brazil to Hatteras), it is sparingly found. These were by far the finest specimens I have ever seen. They apparently lived wholly upon the densely packed bunches of a flat black bivalve, *Melina* ("Perna") *obliqua* Lam. that occurs in quantity at about the low-tide mark on the wall. These poor clams must indeed have a hard time of it maintaining themselves against the rapacity of so active an enemy as the *Murex*. Besides these the wall offered some fine living examples of *Tritonium pileare* L. always showing the curious hairy epidermis of the genus. These seemed as greedy as the *Murex* in browsing upon the helpless *Perna*. Apparently neither of these carnivorous species attacked their prey by boring through their shells, as is usually done by *Natica*, *Urosalpinx*, and other predaceous gastropods. We were unable to observe exactly the *modus operandi*; but the *Murex* seemed to surround the *Perna*, smothering it in folds of its distended foot and probably forcing it through suffocation to open.

Falmouth Harbor, just west of English Harbor, yielded but little to the dredge, but its shores were richer in the "small fry." By searching through the windrows of the flotsam of the beaches, we obtained a number of little *Scalas*, pyramidellids, rissoids, and some of the smaller auriculids. Always about us the many dead *Phacoides*, *Lucina* of several species, *Tellina*, *Macoma*, *Cardium*, *Arca* and other pelecypods gave evidence of no lack of molluscan inhabitants in the harbor, even if they did elude our dredge. Our best and most interesting results were from collecting at low tide among the rocks at the harbor entrance. There quite a different assemblage of mollusks is to be found when once their hiding places could be detected. Two or three species of *Thais* (*Purpura*), *Sistrum*, *Columbella mercatoria* in quantity, *Nitidula catenata* in little colonies *Ultimus gibbosus* with its mottled red mantle covering its lemon yellow shell, *Cypræa cineria*, *Conus mus*, *Marginella avena*, *Pisana pusio*, *Leucozonia cingulifera*, *Latirus infundibulum*, two mitras, various limpets, chitons, etc.,— all were taken in

greater or less quantity. A full list of the mollusks inhabiting the rocky harbor entrance would make quite a report in itself. Probably the most striking form obtained is a very pretty *Turbinella* of an apparently undescribed species. The shell is almost round, deeply corrugated by raised circular ribs and with a bright yellow aperture. Miss Sykes seemed to be the only collector with eyes properly focussed to detect these turbinellas clinging to the rocks, so well concealed are they by their coloration and by the calcareous deposit that further hides them from their enemy (but not Miss Sykes). One of the chief enemies of these rock-living mollusks is a fish of the grouper family that at high tide swims about the reefs examining every inch of their surface for little mollusks that have not hidden themselves very carefully. The limpets and chitons cling too tightly to be dislodged. Collecting in such a locality means the overturning of many rocks, large and small, and is back-breaking work.

Many hundreds of dead and broken shells of the reef are occupied by hermits that are also obliged to keep pretty well under cover. Just without the entrance to English Harbor the bottom is rough with areas of broken shell and coral detritus,—always a dead and unprofitable ground for the dredge. Unfortunately the constantly blowing trades made the sea too rough for our little launch to dredge upon the rocky, current swept island slope, although the 100 fathom line is hardly half a mile from shore. Two hauls only were accomplished on the slope, one at 120 fathoms and the second at some depth supposed to be between 200 and 300 fathoms, 2,500 feet of wire being used. The results seemed to be very meager at the time, but the sorting of the material shows these two to be the richest individual hauls in a total of some one hundred twenty or one hundred thirty made. The mollusks are all small and contain many turrids, *Microgaza*, *Solariella*, *Liotia*, and some peculiar *Triforis*.

Probably the one group most abundantly represented in our entire collecting is that of the Turritidæ (Pleurotomidæ). Not less than fifty species of these interesting little mollusks were taken, many of them being heretofore known by one or two specimens only. A striking species is *Ancistrosyrinx radiata*

Dall, which suggests in miniature a Chinese pagoda. But two species of this peculiar genus are recorded, both Antillean, but we have what seems to be a third, also a Chinese pagoda, but shorn of the many ornamentations of Dr. Dall's remarkable shell, perhaps reflecting architecturally the greater simplicity of an older dynasty.

In Antigua we made a fairly systematic attack upon the land-shells, but the island is no conchologist's paradise. Like all the other islands of the Lesser Antilles, it possesses a very poor molluscan fauna, only "a little more so." Here none of the South American species so commonly met in Barbados is to be found. The only pleurodonte (of the characteristic Antillean group of *Caprinus*) is *P. formosa* Fer. This we finally found after considerable search on Monk's Hill, aestivating upon the upper branches of a smooth-bark tree. As its name suggests, it is a very pretty species, having a curiously patterned shell of white oblique streaks upon a gold and chestnut background. It did not seem to be abundant in any locality. We also took from several stations the single operculate of the island.—*Cistula antiguensis* Sh. The chief molluscan feature of the island is probably the development of the two Bulimulids,—*Drymaeus elongatus* Bolt. and *Bulimulus exilis* Gmel. Both are pretty generally distributed throughout the lower islands of the Antilles, although the former does not reach Barbados. Antigua seems to offer an excellent station for these two and they are ever present wherever there are trees or bushes for them to cling to. The color patterns are numerous and show an endless hybridism that might yield some interesting results to a systematic study. The commonest form of *D. elongatus* that we met is almost pure white with faint traces of color banding, and with or without chestnut color patches about the columellar region. A very striking form from the northern side of the island is white with a series of wide broken bands of purplish chestnut.

The ubiquitous *Subulina octona* Chem. of almost world-wide distribution was, as usual, the first of the species to turn up when we started collecting. Enthusiastic conchologists have become so discouraged and disillusioned when finding this terrible species at every port of call that rewards have been offered for

a land where a guaranty may be had that it will not be found. Two or three little *Opeas*, a small *Helicina*, a *Succinea*, and a *Thysanophora*—all sparingly found, about completes our list.

Nearly all the little ponds and rivulets,—for the most part dry when we were in the island, contain several species of pulmonates. We took three species of *Planorbis*,—one of them the flat disk-like *P. cultratus* Orb., a *Physa* and some large *Ancylus*. Besides these we took one specimen of *Pisidium*.

With the very great development of fresh-water mollusks in the United States and in Central and South America, it seems not a little curious that the Antilles possess no more than a few widely distributed forms. One would hardly expect the smaller islands to show much wealth of species, where the water courses are so small and uncertain, but the larger islands of the northern series with rivers and ponds that are never dry are almost destitute of fresh-water shells beyond a few species that seem to maintain themselves with difficulty. At all events, they have never developed any peculiar genera or species that are very characteristic of an Antillean fauna. The direct contrary is true of the land mollusks.

CHAPTER IX

ZOOLOGICAL NOTES, CONTINUED

ANNELIDS, COELENTERATES, INSECTS

Annelids.—I have already referred to the wonderful display of tube-dwelling worms on the sea-wall surrounding the Dock-yard. It was the outstanding zoological feature of our environment and the source of constant admiration. Just below sea-level they were attached in what seemed to be almost a solid mass reaching down nearly to the bottom, rank on rank of their beautiful tentacled crowns outspread in graceful whorls. When first seen I thought that they were luxuriant growths of plumularian hydroids. These tentacles, or rather branchiæ, have a spread when fully extended of fully a foot, and are by far the largest serpulids that I have ever seen or heard of.

The commonest form was apparently a *Sabella*, having the characteristics of that genus as described by Miss Katharine Jeanette Bush in Vol. XII of the "Harriman Alaska Expedition Reports." The branchial crown is set upon a sort of lophophore somewhat like a double horseshoe in shape, but with a very graceful spiral effect. The branchiæ are close-set and very numerous, some of them as much as six inches long and beautifully barred with dark purplish brown and cinnamon red. The colors, however, vary considerably, some being almost white with indistinct barring, like watered silk. There is a double row of pinnæ on each branchia, projecting upward in full expansion, and inward when partially retracted. A single slender whip-like tentacle is inserted inside the whorl and near the mouth, as are also some tag-like cartilaginous structures which seem to serve as a sort of operculum when the branchiæ are retracted. Below this branchial crown is a stiff flaring collar of cartilaginous consistency, and below this is a diagonally set series of parapodia, each with a stiff brush of setæ which are very slender bristles without hooks or serrations of any kind

Below these is a regular row of parapodia, each bearing a minute tuft of setæ and also a long oval transverse ridge on the summit of which is a line of denticles resembling the teeth on the radulæ of certain snails.

The tubes in which these beautiful worms retract are parchment-like in consistency, but often covered with mud. They are usually six or eight inches long and quite firmly attached to the stones on which they grow. Attempts to photograph this display were not very successful, as the water was not sufficiently clear for the best results. The worms were quite sensitive to stimuli and would quickly retract upon being touched. A great quantity of these exceedingly interesting serpulids was collected and preserved for future study by Miss Mullin.

Another species, superficially much like that just described, was collected by the writer on the roots of the mangroves and later by Miss Mullin in Falmouth Harbor. The branchial crown is bilobed; but when fully extended forms a helicoid whorl of graceful branchiæ which are regularly barred, rufous and whitish. Each of these tentacle-like gills is closely pinnate, having a row of filaments on each side projecting inward and upward from the main stem. On the back or outward aspect of the stem are two sets of organs in pairs, alternating with each other. One set consists of what are doubtless eye-spots, a pair on each of the lighter bars of the gill stem, looking like minute black beads; the individuals of a pair being well separated and occupying the postero-lateral aspect of the stem, each black dot being surrounded by transparent ectoderm cells, the whole appearance being that of quite typical primitive organs of vision.

The second set of organs, referred to as alternating with these, occupy the postero-lateral aspects of the reddish brown bars. They are smooth, whitish filaments in pairs and appear to be tactile in function. The branchia ends in the flattened sword-like whitish filament which is capable of being bent like the end of an elephant's trunk. The tubes occupied by this worm are like those of the species mentioned above.

Several other species of serpulids were collected, but the preserved specimens, although various methods were tried with

great patience by Miss Mullin, give no idea whatsoever of the beauty and grace of these magnificent forms. One species allied to *Amphitrite* had a dense assemblage of slender round crinkled tentacles, almost white in color, forming a tangled mass looking like vermicelli. There were three pairs of profusely branched gills borne on short thick stems. The annulations of the body were marked by sharp ridges bearing parapodia. The anterior part of the body bore prominent shell glands, while the posterior segments bore pairs of short, very wide, flattened tubes with apertures, and were probably nephridial in function. Another form, probably a *Sabella*, made a tube formed of sand and bits of shell. It was much smaller than those already described and has a very dense crowd of branchiæ with what appears to be irregularly distributed eye-spots. It was found under rocks near the Pillars of Hercules. A serpulid which may belong to the genus *Spirobranchia* has the gill filaments branched and densely crowded, while the ultimate pinnæ bear bright carmine markings; but the most remarkable feature is the operculum. This is borne on a straight, rather rigid stalk or pedicel with two opposite wings or vanes which grow wider as they ascend toward the operculum proper. This pedicel expands distally into a trumpet-shaped operculum which is red on its upturned concave surface and has a distinct carmine rim in sharp contrast to the outer flesh-colored surface. From the center of the cup arises a remarkable structure, bright carmine in color, resembling a pair of deer's antlers, each with a "brow-tine" and several forked points. This is set on a base resembling the top of a deer's head in contour. The whole affair, operculum and antlers, is quite rigid, having a cartilaginous consistency. The collar is frilled and extends backward over the thorax like a sort of cape and bears six pairs of parapodia with dense tufts of setæ. This worm forms hard calcareous tubes, smooth and porcelain-like inside. It was found growing on the links of an old anchor-chain in English Harbor.

There were several species of "sea scorpions." One preserved specimen is nearly a foot long and two ends are so much alike that it is hard to tell them apart. One remarkably stout form has a diameter of fully an inch, including the parapodia. The notopodia bear dense tufts of setæ, an aciculum, and dense-

ly tufted gills, a pair to each segment throughout its length. Each tuft of setæ is like a thick paint-brush and each gill is borne on a short thick pedicel which branches so as to bear five terminal tufts of gill-filaments. The neuropodia bears very dense, somewhat flattened tufts of setæ which are exceedingly slender, needle-like and without ornamentation.

Two species of sipunculids were found. One was quite large and was collected in sand under rocks, the preserved specimens attaining a length of as much as five inches. The body is closely annulated throughout and covered with rough nodules without tentacles or hooks. The other species was considerably smaller and was found by breaking open old coral rocks. It differed, however, from those found at Barbados in having no hooklets. The posterior end was abruptly conical or top-shaped, with very distinct rugosities radiating upward from the top of the cone, and was covered with small round tubercles or granulations. The body wall is translucent, showing longitudinal muscles which were sometimes forked and very strong. The anterior end is dark brown and covered with nodules like cobblestones. These in turn appear to be overlaid with fine scales, the edges of which appear to be chitinous and may be homologous with the fine denticles found in the Barbados species. There is, as usual in this group, an eversible proboscis.

A small chaetopod was found as a parasite or symbiont in a long tubular sponge. It was very minute for this group and appears to be without eyes, showing that it has long dwelt in the dark interior of sponges. The parapodia bear finger-like cirri, and the anterior ones appear to bear but a single seta, while those further back bear several. These worms seem to be undergoing a process of asexual reproduction by transverse fission, a few of the posterior segments being abruptly different from the rest as in *Syllis*, for instance.

As a whole, the collection of annelids is probably the most extensive and interesting of the material secured at English Harbor.

Coelenterates.—While there are very extensive coral reefs around Antigua, they are mostly on the northern and western coasts too remote from our quarters to investigate, particularly as the more immediate region yielded ample returns to the collec-

tor. Small patches of coral reef were conveniently located, both in English and Falmouth Harbors; while Willoughby Bay had a fine stretch of reef extending almost across the entrance. We had the opportunity, however, to study the ordinary reef corals at Barbados and felt that our time at Antigua could be more profitably used in the study of other groups. One form, *Manicina*, was common in the quiet waters of Falmouth Harbor, while *Orbicella*, *Astræoides*, *Porites*, etc. were growing in quite shallow water near the shore.

We were much struck with the beauty of a bright purplish blue *Porites* growing on the shoals near Rocky Point. I had never seen corals of this color before. The bright blue, however, disappeared quickly in alcohol, but persists in some dried specimens that we brought back with us.

Alcyonarians were by no means so common as at Barbados. We saw many of the ordinary gorgonians along the reefs in Willoughby Bay, but not in such dense and extensive patches as off Hastings, Barbados. Several fine specimens of *Xiphorgorgia* were secured. The yellow variety of *Rhipidigorgia flabellum* was common, while the purple sea-fans were scarce. As indicated before, I am inclined to believe that these two forms are specifically distinct. There is, beside the marked color difference a great disparity in size. In my experience the yellow form is always small, ordinarily less than a foot high, while the purple form is from two to four feet high when fully grown. The pattern of the branches in both cases is more finely reticulate than in any other species that I have seen. No representatives of the Pennatulaceæ, of the Alcyonacea, nor of antipatharians were secured.

The only representative of Ctenophora was a species of *Beröe* which was collected at night, being very conspicuous on account of its brilliant phosphorescence.

A number of interesting and beautiful anemones were collected and preserved by Miss Van Wagenen, who has kindly placed her notes at my disposal. The largest and most beautiful form was *Condylactis gigantea* with a spread of twelve to fourteen inches and a height of four to seven inches. The tentacles were tubular, smooth and very translucent, colored a delicate green tipped with purple, while the body wall was cadmium

orange. One specimen had the body near the foot colored a bright yellow. This magnificent anemone was found attached to loose stones in shallow water in Falmouth Harbor and sometimes on dead *Manicina* heads.

Aptasia annulata attached itself to the under sides of rock and in deep crevasses from which it was hard to loosen it. The tentacles are barred clear translucent brown and whitish. This is the species which harbors the "pistol crab" already mentioned that thumps the fingers of the collector with the end of its relatively immense chela, a most peculiar and unexpected sensation that makes one jump as if subjected to a sudden electric shock.

Several of the anemones have not as yet been even approximately identified. One is a large form with an inner circlet of tubular tentacles surrounded by a mass of densely dendritic branchiae of brownish color. One of the most strikingly colored anemones had the stomodeum bright green, disk transparent chocolate brown surrounded by a belt of deep blue, one and one-half centimeters wide. The tentacles near the center of the disk are tipped with light grey. Outside of these are others tipped with light orange. The walls are in general brown, but sometimes plum colored. This form resembled the polyps of *Manicina* in that it multiplied by a sort of longitudinal fission, several polyp-mouths appearing without an entire separation of the polyps, as in the confluent calyces of *Manicina* or *Meandrina*. Sometimes seven or eight mouths are seen in a single specimen, much as in the photograph of *Mussa fragilis* given by A. E. Verrill in "The Bermuda Islands," Part V, plate XXXI, fig. 1. Another form had the body deep rich maroon thickly beset with nodules of green, and the disk completely covered with moss-green tentacles. One very small anemone was found growing on an alga. It was yellowish in color. A number of social actinians were found, forming a tough leathery encrustation on the rocks. They are covered with grains of sand which seem to be incorporated in the integument and tentacles and are also found in the walls between the polyps.

The only Scyphomedusa collected was an *Aurelia*, abundant in St. John's Bay. It differed in color from any that I have

seen and does not appear to be figured in Mayer's "Medusæ of the World." It has very deep blue gonads and marginal tentacles.

NOTES ON THE INSECTS OF ANTIGUA

By Dayton Stoner

The island of Antigua is not under so high a state of cultivation as is Barbados; neither is it so thickly populated as that island; consequently natural enemies of insects are not numerous. All these conditions make for a greater and more varied insect fauna than we found at Barbados.

The low grassy lands towards the center of the island furnished a great variety of insects, particularly in Hemiptera and Orthoptera, and collecting with a sweepnet was very productive of results here.

There are few freshwater streams and ponds on Antigua. However, one of these ponds situated about three-fourths of a mile northwest of the dockyard at English Harbor was made the object of a rather intensive study. Among the more interesting forms of insect life found here was the mole-cricket (*Gryllotalpa* sp.) which we had not discovered at Barbados. This insect lives mostly under ground, constructing tunnels a few inches below the surface and feeding upon the roots of various plants which happen to be in its path. The mud shores of this little pond were literally undermined in some places by the tunnels of these peculiar insects. Other groups represented in the pond were water-striders, water-boatmen, (the latter the most abundant of the larger insects) backswimmers, several species of water beetles including both larvæ and adults, dragon-fly and damsel-fly larvæ and adults, various species of dipterous larvæ—in fact the place was found to be a veritable storehouse of entomological material. Of course such ponds offer excellent breeding places for mosquitoes and we found great numbers of both larvæ and pupæ.

At the south end of the island where most of our collecting was done, many localities are heavily wooded. Small cultivated and semi-cultivated places on both high and low lands offered excellent collecting grounds. In many places highly xerophytic

conditions prevail, particularly on the hills in the vicinity of English Harbor. These hills are largely of volcanic origin and the soil is very thin, although it is able to support many harsh and spiny plants. Such situations, however, afforded little of variety or abundance in the way of insect life.

In walking through the wooded districts about Antigua the newcomer is at first struck with the great number of what appear to be climbing vines on the trees. Upon closer examination one finds that these "vines" are really the covered galleries through which the termites or white ants travel from place to place. The tunnels are everywhere, winding about over the trunks and branches of the trees and usually ending in a nest of some size either on the ground or in the trees themselves. The white ants are usually sightless and being averse to the light construct these tunnels when it becomes necessary to cross an open surface. The nests and tunnels are made of pellets of chewed wood fastened together with the sticky saliva secreted by the insects.

A most interesting and, to the writer, unusual place in which to find insects was in the great epiphytes locally known as "wild pineapples," growing sometimes in great numbers on the manchineal and other trees in the wooded districts. Upon carefully removing one of these "pines" from the limb of the tree to which it is ordinarily loosely attached, and turning it upside down, the collector is usually well repaid. Spiders, scorpions, beetles and cockroaches are sure to be found. The large leaves of this plant form a receptacle for water and it is not an uncommon thing to find adult mosquitoes and their larvæ in such situations.

Among the commonest insects on Antigua are the cotton stainers (*Dysdercus* spp.) of which two or three forms occur on the island. These insects are true bugs, usually reddish in color with black and sometimes also with white markings. Adults and nymphs in all stages were found in great numbers during July. These bugs have sucking mouth-parts and by preference feed on the bolls, seeds, leaves, and tender shoots of the cotton plants. When cotton is lacking the bugs will feed on other related plants. In addition to lessening the vitality of the plant by extracting the juices, cotton stainers have been found to

transmit a fungous disease which has become serious in some of the islands of the West Indies; and, indeed, these pests have caused, in part, the almost complete abandonment of the cotton-growing industry in Antigua. The name "stainer" originates from the fact that the cotton lint is discolored by the excrement of the insects and by the fungous disease which gains entrance through the punctures as well as by the crushing of the insects themselves in the gins.

Other kinds of Hemiptera in great numbers were taken from the bushes and grasses in the cultivated and partly cleared areas all over the island. In fact the hemipterous fauna exceeded that of any other group of insects both in abundance and variety. One of the principal families represented was the Pentatomidæ (stink bug) of which more than fifteen species were taken. This group will form the subject of a special report in the near future.

The cleared spaces in and near the woods offered good collecting grounds for butterflies. On ascending Monk's Hill from the south side by one of the numerous paths, great numbers of gaily colored hesperids, nymphalids and lycænids were to be found in the vicinity of a little truck patch where squashes were growing. I do not believe that I have ever seen so many butterflies in so small an area as at this place on July 1st.

In the low cultivated fields along the hills great numbers of larvæ and adults of the boll worm (*Heliothis* sp.) and the cutworm (*Prodenia* sp.) were found and some injury was being done to various plants. Very often moths of different kinds would be attracted by the lights in our quarters at night, the most notable of these being several forms of *Protoparce* and a specimen or two of the interesting blackish noctuid, the "black witch" (*Erebus odora*).

In low wooded areas under dried leaves we found considerable numbers of a large brachyelytrous cockroach; but in reaching out quickly to seize these agile fellows it was necessary for the collector to look sharply in order to make sure that a scorpion or two did not lurk close enough to be dangerous. Centipedes were not uncommon under stones in moist places and a good sized tarantula would now and then be taken, while his smaller brethren were not at all uncommon.

At Barbados it has not been an uncommon thing for Mrs. Stoner and myself to be followed about on our collecting trips by from one to as many as eight or ten little black, more or less clothed, urchins. However, we found that the native Antiguanes were neither so inquisitive nor so insistent on offering their services in collecting specimens. This was a great relief to us and much less trying on one's temper and vocabulary.

With such a variety of habitats and faunas represented, collecting was indeed a pleasure and much still remained to be done at the expiration of our allotted time of four weeks upon this interesting tropical island.

NOTES ON THE GEOLOGY OF ANTIGUA

By A. O. Thomas

Antigua is located about 200 miles to the north of Barbados. It forms an intimate link in the Lesser Antillean chain. Physically it is a part of the same bank as is Barbuda, an island about two-thirds its size and separated from it by approximately twenty-five miles of shallow water nowhere much exceeding 200 feet in depth. The islands of Guadeloupe to the south and Montserrat to the southwest are not much farther away than is Barbuda, but the water between them and Antigua is from 2,000 to 2,500 feet deep. To state it in another way, an uplift of a little over 200 feet would not only connect Antigua and Barbuda but the uplifted bank would form a new island whose area would be probably twice that of the present island of Guadeloupe. Many lines of evidence indicate that the two islands have been united in relatively recent times. A study of the land snails of the two islands, for example, brings out some striking similarity while the notable similarities of the reptiles led one scientist to remark that "Barbuda is a herpetological appendix of Antigua." These facts emphasize the recency of the diastrophic movements which have been such important factors in modifying the geology and in affecting the distribution of life in the whole Antillean region.

A cruise along the windward side of the island gives the impression that it is very rough, and, in fact, such is the case, for the hills are numerous and steep-sided and there is but lit-

tle flat land. Bold headlands, on whose sides cling the huts of the natives, jut out into the sea; in places they alternate with swampy bay-heads, in which thrive mangroves and other halophytes. The leeward side is not so rugged but it is deeply indented by many shallow bays and fringed with a multitude of low-lying islands. Indeed, there is no dearth of indentations all about the island, but they are in the main too shallow to admit vessels of any considerable draught. The island is surprisingly dry and there are no streams of importance. The vegetation is of the xerophytic type and is very harsh and thorny.

Geographically, Antigua is divided by the low central belt into three nearly equal parts. The southwestern part is hilly and rough with many peaks rising from 1,000 to 1,300 feet,—the highest being Boggy Peak, 1,330 feet. The central region is lower and flatter and is indented at one end by St. John's Harbor and at the other by Falmouth and Willoughby bays. The northeastern part is rolling, with low ridges and hills of limestone marl. Since the geology of the island is different in each of these districts they may be further considered from that point of view.

The southwestern part is generally known as the "volcanic" portion, and though many of the hills have the appearance of extinct volcanic cones yet a close examination reveals little if any evidence of rock of recent volcanic origin. However, the rock is much metamorphosed and contains weathered and transported particles that are apparently of volcanic derivation; in places the rock reveals fairly clear stratification, while in other places the bedding is almost, if not quite, obscure. Where the strata are definite they dip at various angles, but the main dip is to the northeast. These hills have a thin soil which supports a scrubby lot of low trees and thorny bushes, but in places there are fairly large forest trees. Between the high steep-sided hills, as seen in a trip to the southwestern corner of the island, there are flattish valleys which meet the bases of the hills abruptly; they are fertile and apparently well drained as seen in the vicinity of Jolly Hill, at Belden's estate, and others; the seaward ends of the valleys are in many cases estuarine and in places filled with "dead sands" or mangrove swamps. An in-

teresting practice of the natives in this part bespeaks the limeless character of the local rock. In order to obtain lime for domestic purposes massive colonies of *Millepora*, *Meandrina* and other reef corals are torn loose at low tide and dragged ashore where, after exposure for a time to the wind and rain in order to remove the salt water, they are heaped upon a pile of wood and burned into a fair grade of lime.

The central area extending diagonally across the islands is underlain by thin-bedded mudstones, volcanic sandstones, and conglomerates. Their lithology from point to point is very variable and there is evidence which shows that some of the rock is of fresh water and that some is of marine origin. The dip of the beds is not quite the same at any two places seen, but the general dip is to the northeast. Locally, there is evidence of faulting and, too, of folding, which features point to the complex crustal disturbances which have affected the island. In places between the mudstones and associated rocks there are bands of dark chert and in some localities fragments of petrified wood are plentiful. In places the chert contains beautiful silicified specimens of fossil shells of fresh-water snails belonging to the genera *Hemisinus* and *Planorbis*. A fine lot of these fossils was obtained at Corbizon Point and at Ledwell Point along the coast north of St. Johns. From an exposure in the street at the Cathedral in St. Johns, a small lot of marine shells was collected from a hard tough limestone and some from a thin bed of soft shaly marl; they belong chiefly to the genus *Turritella*.

One drawback of the central area is the difficulty of obtaining an ample supply of water for domestic purposes. Wells sunk to any considerable depth yield brackish water; or, in case the water is fresh, the amount is generally insufficient. For this reason, resort must be had to rain-water caught in cisterns and reservoirs. For city and village supply water is obtained from large catch-basins situated in the hills in the southwestern district from whence it is piped. This low central belt, whose level or rolling topography is broken by a few rather prominent hills such as Monk Hill, Drew Hill, and Scott Hill, was, geologically speaking, not long since covered by the sea. Antigua at that time was composed of two small islands separated by a

strait. Some evidence of the former presence of the sea is to be found in the loose marly deposits occurring in several places between English Harbor and St. Johns. Such a deposit a few hundred yards north of the Dockyard yielded quantities of slightly bleached shells,—some of the valves still in apposition. They belong to recent forms most of which were found living in the neighboring bays. The following genera are the commonest: *Arca*, *Cardium*, *Isocardia*, *Lævicardium*, *Cythere*, *Donax*, and *Pecten* among the pelecypods; and *Polynices*, *Cerithium*, *Astræum*, and *Strombus* among the gastropods. Some branches of the coral *Oculina* are also common. Similar deposits occur near the Botanical Gardens at St. Johns.

The northeastern belt is the limestone area of Antigua. The overlying soil is fertile, tractable, and marly; the region is rolling, and there are a few hills and ridges ranging from 100 to 400 feet above the sea. The strata dip gently to the northeast, are slightly folded in places, and are cut by a number of strike faults, some of which have considerable throw. The unweathered limestone is fairly pure, crystalline, and hard. It is Oligocene in age as the fossils attest, hence it is much older than the white limestones of Barbados and more nearly contemporaneous with the radiolarian earths and globigerina marls of the Scotland district. Good exposures may be seen at Hodge Point and vicinity in the extreme northern part of the island and at Lynch's on the northeast shore of Willoughby Bay, also both north and south of Nonesuch Bay on the windward coast. The limestone is abundantly fossiliferous and a representative collection of well preserved fossils was obtained. In places the limestone is crowded with smooth, round, disc-shaped forms which have been called "*Orbitoides mantelli*." This doubtful foraminifer is fully three inches in diameter and from one-sixteenth to one-eighth of an inch thick. At a locality on the windward coast an impure limestone stratum was found in which similar forms only one-fourth of an inch in diameter and from one-fifteenth to one twenty-fifth of an inch thick occur densely crowded in the matrix. In places they weather out and hundreds of perfect specimens were obtained. Several genera of pelecypods also were found, the most common being *Pecten* which is represented by two or three species and *Ostrea*,

which is also represented by two or three species, one of which is strikingly large, with heavy thick valves, and coarsely ribbed. Gastropods are rare and are chiefly represented in the collection by a few specimens of a very pretty *Scala*. A number of species of small brachiopods were found. Corals occur in abundance and in great variety; some of them as they appear in the gray crystalline limestone have an unexpectedly Paleozoic aspect at first sight, so complete is their calcification. By far the most sought-for fossils were the sea-urchins. The tests of the urchins are very well preserved and seldom, indeed, does a paleontologist find so many and such perfect forms. They were found in "spots" although an occasional specimen could be expected at nearly every exposure. At one small spot along a cliff on Gaynor's stream nearly forty perfect specimens were removed from the weathered stone in an hour's time. In all between eighty and one hundred specimens of these interesting forms were collected during one or two visits to this locality. The specimens vary in size from less than one inch in diameter to large individuals six or seven inches across and they undoubtedly represent several genera and species.

In many places between the soil and the limestone there is a bed of powdery marl from one to several feet thick. This marl often contains many bleached and brittle shells of land-snails. At Hodge Point, for example, several species occur, among them a species of *Pleurodonte* which is larger and more robust than any of the living forms of the genus seen on the island. Along with the fossil *Pleurodonte* are representatives of the genera *Bulimulus*, *Cistula* (?), *Succinea*, and *Helicina*. According to Mr. W. R. Forrest of St. Johns, *Pleurodonte* is not found living on this part of the island; but we found it plentifully in the woods on the slopes of Monk Hill ten miles away, but with much smaller shells. *Helicina* is extinct on Antigua, but a very closely related species lives abundantly on the island of Barbuda. These "semi-fossil" land snails were found at several places in the marl of the limestone area,—a small lot from near Blizzards Mill and another from near the Rectory in St. Philip may be mentioned.

During the prosecution of the work much valuable aid was given by several people. Mr. A. E. Collens of the Government

Laboratory at St. Johns was especially helpful. He furnished books and maps, offered free access to unpublished notes on the geology of the island, and not only served as guide but furnished conveyance to remote parts, thereby saving valuable time. In the field and in drives over the island, he contributed many interesting facts about the geology and natural history of the places visited that would otherwise have escaped attention. His home was the geologist's headquarters while working in the neighborhood of St. Johns and his and Mrs. Collens' unbounded hospitality is one of the pleasant recollections of the expedition.

With rare good fortune an interview of a few hours was had with Sir Francis Watts, who came ashore at St. Johns while *en route* from New York to Barbados. Sir Francis formerly lived for many years in Antigua and he is remarkably well acquainted with the geological and other natural features of the island. In spite of the regrettably brief conference, many very important facts and stimulating suggestions were learned which proved truly helpful in understanding some of the problems encountered,—a few of which unfortunately were only hastily studied during our brief stay. Writers on the geology of Antigua have differed more or less radically among themselves on several interesting points, due in many cases no doubt to a necessarily hasty examination of the field; but the keen observations of Sir Francis, extending over a long period of years, are well founded, and his conclusions are in conformity with the fundamental geological history not only of Antigua, but of the whole Antillean province as well.

A set of the land snails of Antigua and also a number of the much-coveted *Helicina* of Barbuda were generously presented by Mr. W. R. Forrest of St. Johns. Mr. Forrest is well informed on the natural history of Antigua and has been a collector and keen student there for many years. He freely offered many valuable suggestions about collecting grounds and exposures of interest to the geologist. A trip with him to the northwest part of the island proved very profitable. Mr. Forrest is a most pleasant and courteous gentleman and we regret that our acquaintance was necessarily so brief.

Mr. Oliver Nugent of St. Johns kindly loaned some interesting papers dealing with the geology of Antigua. His grand-

father, Dr. Nicholas Nugent, wrote the first published account of the geology of the Island, which appeared in the "American Journal of Science" in 1819, just one hundred years ago.

Investigation in the St. Philip parish was greatly facilitated and made very pleasant by the friendly coöperation and hospitality of the Rev. Thomas Streater, rector of the parish, and his estimable wife. These good people served as guides to several interesting localities and the welcome extended not only to the geologist but to other members of the party at the rectory could not have been more whole-hearted. Mr. Frank Goodwin, also of this parish, was very helpful in securing a fine lot of fossils on his estate at Gaynors.

A report on some of the geological features studied is in preparation.

BOTANICAL NOTES

My son, Willis Nutting, has furnished me with his notes on the flora of Antigua. He does not claim to be a botanist, but did most of the work of the expedition along that line. While the identifications are in some cases only approximate, he was helped a good deal by Mr. A. E. Collens and the Rev. Hal Shepherd, who have considerable knowledge of the plants of the island. Many of the names were secured from the "Journal of Botany."

On account of the lack of moisture and the tropical climate, the flora is distinctly xerophytic; hence various cacti and other thorny plants are much in evidence. A most prominent feature in the landscape is the *Agave americana*, the flowering stem of which stands twelve or fifteen feet in height. This stalk is very pithy and is used in constructing light raft-like boats which are used as rowboats by the natives. The pith is also used for razor strops. The "prickly pear" (*Opuntia tuna*) is common but less conspicuous and therefore all the more dangerous. A thornless cactus is found here, said to have been the basis of the form produced by Burbank. It is almost absolutely thornless, but much less fleshy than the ordinary prickly pear with which it was crossed to form the hybrid produced by Burbank with the idea of providing an abundant and satisfactory food for cattle. Thorns are everywhere and most troublesome to the

explorer and collector. The "organ pipe" cactus (*Cereus insularis*), with its candalabra-like erect branches, is prominent on the hillsides. The stems are hard and woody and not sappy like other cacti. The "barrel cactus" or *Melocactus communis*, with its curious red cap, gives a bit of color here and there, bristling with its many rows of needle-like thorns. Several species of shrubby *Acacia* catch the clothes of the intruder; while a low vine-like plant known as the "wait-a-bit" with compound leaves like the tamarind and cruelly recurved spines which are concealed under the stem, holds one with vexatious tenacity as he tramps through the thickets. This is provocative of much profanity, as its weapons are concealed and their wound cruelly painful. It bears a round bluish seed that is used in making necklaces. Another local name is the "nicker plant." Many other thorny vines are constantly encountered and way-lay the traveler in a most irritating manner.

Many fine mahogany trees (*Swietenia mahogoni*) line the roadsides and offer a most grateful shade, supplanting the elms of our own streets. I do not know whether the wood is used commercially or not, but it seems abundant. The tamarind (*Tamarindus indica*) is also a good shade-tree, and a grateful drink is made from the fleshy substance surrounding the seeds in the large bean-like pods. Here, as in Barbados, the most conspicuous flowering tree is the flamboyant tree (*Poinciana regia*) with widely spreading branches. The leaves are compound, somewhat like those of the tamarind, but at the time of flowering are inconspicuous; while the brilliant mass of scarlet blossoms, each with a white center, stands out with the vividness of flame.

Another tree with a scarlet blossom is the *Cordia*, the hard wood of which is said to be excellent for making furniture. The "frangipani" (*Plumeria alba*) has club-shaped branches, slender leaves and white blossoms, and exudes a milky juice. The mango (*Mangifera indica*) besides yielding the well-known fruit, is an excellent shade-tree, the leaves being a dark shiny green. Cocoanut palms are common and there are some large groves under cultivation near the entrance to St. John's Harbor. The "loblolly," a shrubby tree with ovoid leaves and a whitish trunk, is common near English Harbor.

The manchineel (*Hippomane mancinella*) is very common near the water. It has bright green leaves like apple leaves in shape, and bears a fruit which looks almost exactly like small green apples. The juice is whitish and causes blisters. This is regarded as one of the most poisonous trees of the island against which visitors are carefully warned. Although members of our party handled it freely, it is doubtful if they received any material injury, although anyone venturing to eat one of its apples would be seriously poisoned. It is said that they are eaten by the land-crabs and that the flesh of the crab is sometimes poisonous on that account. There is another so-called apple, the "sugar apple," that bears little resemblance to our northern fruit. The "apple" itself seems to be made up of a number of seeds, each surrounded by a fleshy pulp, the whole bearing some external resemblance to a green pine-cone. The leaves are like apple leaves, but more slender. A few Australian pines (*Casuarina equisetifolia*) are found, but it is not common as at Barbados, and has been introduced in comparatively recent times. The "white cedar" (*Tecoma leucoxydon*) is not at all like our cedar trees and bears flowers resembling those of the catalpa. A single baobab tree with a trunk sixteen feet in circumference is in the rectory grounds at Falmouth. The "sea grape" (*Coccoloba uvifera*) grows on the seashore. It is a low stunted tree with very large, round, light green leaves and a fruit which greatly resembles bunches of grapes and is said to be edible, although we did not find it ripe. The "sand-box" tree (*Hura crepitans*) is one of the large trees of the island. The fruit is shaped like a flattened tomato, brown, and divided into sections which fly apart. The green ones were formerly emptied of their contents and filled with sand to be used for blotters.

There are said to be three species of mangroves, the most common being *Rhizophora mangle*. It forms dense growths on mud flats which are submerged at high tide. Shoots are sent down from the branches into the mud, where they take root. The trees stand on their tent-shaped mass of prop-like roots which make a maze upon which it is possible, though precarious, to walk. The roots which form at the ends of the shoots are not deeply embedded and can usually be lifted out of the water. In some places these are covered with a dense growth of oysters

which are very good eating, as well as the oyster-like *Perna*. Many tube-dwelling worms, tunicates, etc. encrust these roots. The seeds germinate while on the trees and form roots which are club-shaped and drop off into the water, where they may float a long way before becoming attached to a suitable bottom.

Several species of trees, notably the loblolly and manchineel, are fairly covered with epiphytes, the most prominent being two species of *Tillandsia*. One is called the "wild pine" which looks a good deal like a pineapple plant growing on its branches. The leaves converge basally so as to form a sort of cup which usually holds a considerable quantity of water in which our entomologists found many species of insects. The other species of *Tillandsia* is called "old man's beard" and has much smaller and more slender leaves than the wild pine. The yellow orchid (*Oncinium lemoneanum*) is often epiphytic in habit, and has small basal leaves and a tall flowering stalk with lemon yellow flowers. A pink orchid resembles this in the shape of the flower but appears always to grow on the ground.

A small species of water-lily is found in a little pond on the "middle ground." It is probably *Nymphia ampla*. A pink flower resembling the phlox grows near the water on Barclay Point. It is known locally as the "periwinkle," and botanically as *Vinca*. The wild yam is a trailing vine growing on the sand and with a large purplish pink blossom resembling the morning glory.

At the time of our visit, which was near the end of the dry season, the native flowers were not conspicuous or particularly attractive. There are said, however, to be many beautiful species that bloom during the wet season.

There are several plants which yield seeds that are used extensively in making necklaces and other fancy articles manufactured with considerable skill by girls and women and sold to tourists who come ashore from steamers. The most abundant and conspicuous of these are the "Job's tears;" very light blue, and oval in shape. These grow on a vine which climbs on the trees and bears long pods which, ripening, turn inside out, exposing the inner surface which is a very bright crimson and a row of seeds or Job's tears, which show in beautiful relief against the flame-red background. In the Hawaiian Islands,

there is a kind of Job's tears which grow on a sort of grass. The "crab-eye" is borne on a small leguminous vine (*Abrus precatorius*) which twines among the grass and bears pods like those of peas. The seeds are brilliant scarlet with a large black spot on one side and glisten as if varnished. They are used in making necklaces, and the natives sometimes call them "jumbie beads."

The wild tamarind is a small tree with fine compound leaves. The seeds are small brown, oval and comparatively hard. These are used in making small mats, purses, etc. They are sometimes dyed black and used with the "crab-eye" with which they form a very pleasing contrast in color.

CHAPTER X

ANTIGUA

Antigua (pronounced locally "Anti'ga") is one of that part of the West Indian chain known as the Lesser Antilles, and the administrative center of the more restricted group known as the Leeward Islands. It is in latitude 17 north, and the exact position of English Harbor as given by the Admiralty chart is latitude 17 north, longitude 61 west.

The island is oval in general shape, but with many deep indentations of the coast line, in which it differs notably from Barbados. It is about twelve miles across from east to west and nine and one-half miles from north to south, with a land surface of about 108 square miles. As compared with Barbados, it is almost mountainous, but it is quite flat in comparison with other Leeward Islands such as Dominica and St. Kitts; and these latter, with their high mountains secure a much more generous supply of moisture than Antigua. Although it suffers in scenic impressiveness when compared with its neighbors, it was nevertheless charming to the eye of the Iowans and really mountainous as seen by the dwellers of the prairie. The northern and central parts of the island are divided by a valley which geologists tell us was once filled with water, when there were two islands instead of one. This valley is the seat of an extensive sugar industry and contains a number of fine estates which contribute their cane to the central factory at Gunthorp's, of which more will be said later. Still better sugar land lies to the north of the central valley. The most picturesque part of Antigua is in the southern portion in the vicinity of English Harbor, which is almost entirely surrounded by high hills. The trip by motor boat from St. John's to English Harbor affords an exceptionally fine panorama of rugged coast scenery with here and there deeply indented harbors; several of which are almost land-locked, while others have their entrances protected

by coral reefs. Here and there are stretches of sand beaches and back of them very picturesque villages with thatched huts under the ever graceful palm trees. The surf along this coast is heavy, being kept up by the strong trade-winds which were continuous during our stay. The headlands are high and end in lofty cliffs, against which the white-crowned breakers leap to a height of 100 to 150 feet in their ceaseless attack. The constant bombardment results in erosive phenomena on a grand scale, best exhibited perhaps by the "Pillars of Hercules" so often mentioned on preceding pages and excellently well pictured in the accompanying photograph.

The island is at a disadvantage agriculturally on account of its scant water supply which is at all times precarious and sometimes results in serious droughts. St. John's the capital, is supplied from reservoirs; but in the country districts the problem of water for domestic use is a serious one, as there are few springs and throughout the central valley the water obtained from wells is brackish and unpalatable. The main dependence is on cisterns which are often owned by the government and used in common by the inhabitants of a village or district. There was one near English Harbor and at certain times during the day a procession of women would pass from the common pump, each with an oil or gasoline can filled with water poised on her head. Even small children were thus burdened, but the men seemed entirely immune from such labor. These common "wells," as they are called, are in charge of the police and there is much wrangling among the negroes waiting for their turn.

Another disadvantage suffered by Antigua is the absence of a suitable harbor for large vessels. This is true of most of the islands, but here, although St. John's has an extensive harbor, the water is so shallow that passenger steamers are compelled to anchor about three miles from the town and passengers and their luggage are transferred in a decrepit steam launch to the government landing, an uncomfortable procedure if the sea is choppy or a rain-squall comes on.

Another thing that strikes the writer unfavorably is the absence of hotel accommodations for transient visitors. There is but one hotel, the "Esperanza," which is limited in the amount of room and perpetually filled with permanent patrons.

This lack of accommodation for strangers was a serious thing for our party, as will be seen later. If as many as three strangers arrive simultaneously and unexpectedly at St. John's, the name "Esperanza" proves a delusion, as they will be informed that there is no room for them. The manager, an excellent lady, by the way, shows no inclination to enlarge her business, bring apparently entirely satisfied with her permanent guests.

This situation in a town of nine thousand inhabitants seems almost incredible to the visitor from America where every town, even the smallest, has some sort of a hotel for the transient visitor. A moment's reflection, however, will show that there is nothing unreasonable about it, as there are *practically no transients*, at least none that are apt to stay over night. On steamer day, which comes about once a week on the average, a few of the passengers take a run ashore and perhaps get a meal, and an excellent one it must be conceded, at the Hotel Esperanza, and return to the steamer before night. If anyone has business to transact, it can usually be attended to in a few hours without staying over between steamers, which would usually mean stopping over about two weeks. People who visit Antigua for social purposes usually accept the abundant hospitality of friends who are resident there; while officials on government business are delightfully provided for at Government House. And so there is little incentive to keep a hotel for the benefit of transients. In the United States, on the contrary, almost every town, however small, has its railroad and at least one train a day each way. Commercial travelers are constantly coming and going and there is real need for the accommodations afforded by the "Grand Hotel," "Palace Hotel," or whatever it may be called.

Now that the war is over the present writer sincerely hopes that many Americans will enjoy the really delightful experience which would reward him should he decide to make the acquaintance of our neighbors, the Lesser Antilles. In this event, it would be greatly to the interest of all concerned if some sort of reliable hotel accommodations should be provided at Antigua, where the visitor would find much that is well worth while in the way of novel experiences.

The island is flanked by many stretches of extensive coral reefs, particularly on the northern and western coasts, which are on the lee side and where there is an excessively broken coast-line and many small islands. Indeed it would be hard to find a better exhibit of thriving corals of many kinds than is shown here. The condition is almost ideal for the study of marine invertebrates, and a permanent laboratory for continuous and extensive work would be well worth while.

The center of scientific enterprise is the Imperial Department of Agriculture under the direction of Mr. A. E. Collens, Government Chemist, and the local department under Mr. Jackson. These two seem to work in perfect harmony and with excellent results. As a matter of fact, it is difficult for the stranger to differentiate between the two departments, so close appears their coöperation. There is an exceedingly interesting botanical garden just outside of the city of St. Johns, which is laid out with much art and well kept up. Adjoining it is the office and the laboratory connected with the local department, where various agricultural experiments are under way.

The jurisdiction of Mr. Collens extends to the other Leeward Islands colonized by Great Britain. His office and laboratory are above the postoffice at St. John's, and here are carried out important investigations of practical value regarding the raising of sugar-cane, its treatment, and other agricultural enterprises, including soil analysis, various qualitative and quantitative tests of the cane and products derived from it. Much attention is now being paid to the onion industry and it is hoped that this will soon be profitably engaged in on a large scale. For a number of years onions have been grown for export. Ten years ago the annual crop was valued at £221. It seems that the seed is imported from Teneriffe.

Of course sugar is the main thing here as at Barbados, but there is a relatively much smaller area under cultivation. The guide-book says that about 20,000 of the 68,900 acres of land are under cultivation, most of it being devoted to sugar.

The central factory, or "Gunthorp's" is located not far from St. John's, and from it radiate a number of narrow gauge railways that penetrate many of the more important estates. The cane is loaded on cars which are hauled to the factory by small

locomotives that look almost like toys. Here it is unloaded by machinery and taken by a huge carrier to the knives which cut it up into short lengths. Then it passes through a series of rollers which crush it, extracting about 94 per cent of the juice containing the sucrose. Last season 47,965 tons of undiluted juice were extracted by this factory. The "chewed up" residue of the cane is known as "megass" and is transferred by carrier to the furnace where it provides enough fuel to supply the heat and power needed for the treatment of the juice, which is too complicated to describe here.

From an article entitled "Review of the Work of Two West Indian Sugar Factories" in the "Agricultural News" of September 7, 1918, I gather the following items regarding the Antigua factory. There were 64,282 tons of cane treated during the season, from which 7,316 tons of commercial sugar were extracted; that is, it took 8.8 tons of cane to yield each ton of sugar. Molasses to the extent of 332,239 gallons was also manufactured. The cane was found to be composed of 68.3% of water, 16.05% of fiber, 13.1% of sucrose, and 1.04% of glucose, with 1.51% of "non-sugars."

We were shown every courtesy by the management and visited the factory several times, both by night and in the daytime. Although largely ignorant regarding the sugar business, the writer was impressed with the up-to-dateness apparent throughout the establishment. There was a feeling that here was an enterprise managed in a thoroughly modern and scientific manner by men who knew their business. It seemed more like United States push and energy than anything else I saw in the islands.

As before indicated, the most delicious vegetable product that we found at Antigua was the pineapple, or "pine." One cannot help feeling that if this superbly flavored and juicy pine could be made known to the American public it would command a very satisfactory market. In its golden lusciousness, it is fit to set before the gods, and one experience is enough to make a man long for more during the remainder of life. It seems that the pines are subject to a disease called "black heart," which causes them to become rotten inside without any external evidence. The many delicious specimens brought to us by the na-

tives and sold at a reasonable price furnished very little sign of this disease, and I for one, am loath to believe that anything with so noble an exterior and so sweet a flavor can be guilty of harboring a black heart. During the year 1909, the last of which I find a record, the pines were exported to the value of £828, while back in 1903 the crop yielded a revenue of £2,762. It is to be sincerely hoped that someone will find a way to prevent the black heart and introduce the Antigua pine to an appreciative world.

Most of the people are agriculturalists in a small way, working little plots of ground which they rent from the government for a few shillings per year. Here they raise small quantities of garden truck such as yams and potatoes for their own use, the women doing a good share of the work in the field as well as in the home. Many of these people are abjectly poor, as wages are very low and the war has inflated the prices of most of the ordinary necessities of life. These negroes are as a rule less independent and aggressive than at Barbados, but also somewhat less efficient. They are ordinarily neat in person, although their clothes may be in tatters.

I was told by a prominent planter that eighty per cent of the births were illegitimate. That being the case, there is little stigma attached to unmarried unions and public opinion does not act as a deterrent. Indeed this gentleman, who by the way is quite prominent in both the agricultural and religious life of the colony, believed that these unlawful unions were in general happier than those legalized by the church. His argument was to the effect that so long as the bond was contingent upon mutual agreement and satisfaction, the man, knowing that the woman would leave him if not reasonably well treated, would be fairly kind and considerate. The usual arrangement is for him to pay the woman three shillings per week, for which sum she is to all intents and purposes his wife, and attends to the household duties and also her share of the field work. If there are children born to them, he adds an extra shilling per week. This arrangement being perfectly well understood and according to custom, is regarded as quite proper by their friends and neighbors and does not involve loss of self-respect. In fact my informant thought that it worked well.

Now if these people were induced to be married by some well meaning adviser, the situation, according to this gentleman, became worse. The man, feeling that the woman is bound irrevocably to him, becomes less considerate and in fact often "beats her up" when displeased in any way, which seems to be a rather common custom of the country. The woman on her part demands more of the income of her lord and master, being now raised to the status of a legal wife. The result is often continual bickering and less real happiness than during their former unmarried state.

We found these people courteous and obliging. They always greeted us when passing with a smiling "good mornin' " or "good evenin'." The children almost always ran out and begged contributions for their missionary boxes, but there was less general begging in the country districts than in St. John's.

There is much that is picturesque in the small hamlets along the highways and little clusters of thatched houses among the palms. Some of the more out-of-the-way villages were really beautiful, being tucked away in little valleys surrounded by flowers and graceful tropical plants and flowering trees. In some of these places one might easily imagine himself in central Africa or the Philippines, so foreign is the whole environment.

Several of the black men that we met impressed us as far superior to the ordinary negro of our southern states. They had been well educated and spoke the purest kind of English with a remarkable fluency and good choice of words. One very striking fact is the almost entire absence of profanity or even slang, not only on the part of the well educated negroes but even with ordinary country folk. Indeed I know of no locality in the United States where the common people use better English than do those of Antigua. Of course their inflection and accent often seemed strange to us and words were employed that are not in vogue in America; but nevertheless they were usually good English and well chosen.

One man that we met out in a boat after turtles, was, I believe, not at all inferior to the most highly educated of our party in his excellent use of the mother tongue and choice of vocabulary.

The women, as is usually the case, have tongues of their own and can use them vociferously on occasion. One often comes upon groups of them in the little roadside markets which seem to be quite a feature here. The country people for miles around came with their baskets of vegetables, fruits, eggs, and other commodities, to some center where they were met by others from St. John's. Here the trafficking is greatly enjoyed apparently, and the people from the town trudge back with their purchases on their heads.

The women are practically never bare-headed and usually have their heads swathed in thick turbans, often of gorgeous hues. We sometimes saw men and boys with thick caps, some of them having ear-flaps, working in the hot sun. When evening comes, the women seem to want still more head covering and also wraps of various sorts. One favorite place for gossiping here, as in the Bible lands and times, is the well, which in this case is a cistern. Substitute old gasoline and kerosene cans for the graceful water jars of Bible pictures and we find no other alteration necessary to make the scenes the same. The weight of a five-gallon can full of water does not seem to concern them at all and they will stand and talk with no apparent consciousness of the burden.

The main roads on the island are good and kept in very fair condition for automobile travel. Most of the officials and planters have cars, but the common people either walk or ride on ridiculously small donkeys. Loads are either carried on the heads of pedestrians or on donkey carts. I saw few four-wheeled wagons of any kind, and the matter of transportation is usually difficult. It is hard for the northerner to understand why the ordinary farm wagon or at least some sort of truck or dray has not come into general use either here or at Barbados. As before indicated, most of our provisions were brought to the Dockyard on the head of a girl in her teens. When the donkey cart came, which was twice a week, the load it carried was no more than could be transported by an ordinary push-cart at home. Of course heavy loads are conveyed to various points on the coast by sloops such as we employed to bring our effects to English Harbor.

Here, as at Barbados, the Police force is made up mainly

of negroes who, in Antigua, are under the immediate command of Captain Downing, an officer who has seen much service and was at one time a member of the mounted police in Africa. The men are well set up and well drilled, and impress one with their soldierly bearing. There is also the "Defense Force," made up mainly of white men, both cavalry and infantry, and they also seemed to be under the direct command of Captain Downing. Both of these, however, are under the ultimate jurisdiction of Colonel Bell, who is at the head of the military organization of the Leeward Islands as a whole. He is one of the finest looking officers that I have seen and would be a striking figure in any group of military men,—handsome, clear-eyed, affable in manner in ordinary intercourse, but stern enough on occasion. The qualities of the Police and Defense Force were well brought out shortly before we called at Antigua on the way to Barbados, in the "Riot" of 1918.

It seems that there was much discontent among the negroes on the sugar estates. Some wage question, I believe, accentuated by shortage of food due to the war. The cane was burned on some of the estates, and serious threats made against the owners, who were usually white men. Where there is so great a preponderance of blacks there is always the fear, latent or expressed, of the dreaded race riot. Some of the leaders in the cane burning were arrested and this led to threats of reprisal on the part of the blacks. The situation grew rapidly worse; the Police and Defense Force were summoned and stood under arms. Some property was fired in the city of St. John's and the negroes gathered in an excited mob threatening the militia. The riot act was read and pleas were made by various officials, which were answered by taunts and threats. Then the mob commenced to stone the men standing under arms. Colonel Bell took command and showed the greatest coolness and self-restraint, hoping thus to avoid bloodshed.

This passivity of the forces was mistaken for timidity and the negroes yelled "You're afraid to fire!" It seemed that someone had told them that the militia could not fire without direct permission from the King! The blacks were now openly threatening to sack the town, and the families of the officials were in serious danger from one of the West Indian race riots that have

at times been accompanied by frightful excesses. Still the Police and Defense Force stood with stones coming more and more frequently. Many had already been struck and blood was running from a wound in Colonel Bell's face. Night was coming on and it was evident that the blacks would be beyond control in the darkness.

Colonel Bell quietly moved among his men, telling each one to keep track of some one of the more aggressive negroes and when ordered to fire to be sure to get his man. In order to get rid of the black women and boys who were swarming among the men, urging them on in a perfect frenzy of hate, the order was given to fire over their heads. This resulted in a great scattering of the women and boys, while most of the men held their ground. Immediately after this the order was given to fire to kill, and a number of the leaders were stretched out either dead or wounded. This ended the affair, as the mob was thoroughly cowed by the slaughter of their leaders and scattered at once in the dusk of the evening, running in terror to their homes where a number were arrested without further trouble.

The next day two French war-vessels, summoned by cable, made their appearance and a French Admiral came ashore and offered to clean up the island with machine guns. The affair was over by this time, however, although the prompt appearance of the allies had an excellent effect and the blacks have since been quiet.

His Excellency, T. A. V. Best, Acting Governor of the Leeward Islands, proved his friendship and goodwill toward the expedition in every possible manner. He approved the concession granting the use of the Dockyard for quarters and laboratory during our stay, and recommended that all of our effects be passed free of duty without being taken to the customs house. They were, as already stated, trans-shipped unopened to the sloop "Resolute" in the Harbor and immediately sent around to the Dockyard. The Defense Force also gave us the use of such furniture as was at its disposal for fitting up the quarters.

Governor Best was occupying his official position by one of the accidents of war. It seems that a new Governor, Sir Edward Merewether, had been appointed about the time of the beginning of the great war. He was then serving in Africa; but,

while on the way to be installed in his new position, the "Appam" on which he was a passenger was captured by the German raider "Moewe," and he was required to give his parole not to serve in any military capacity during the war. Now the Governor of the Leeward Islands is commander *ex officio* of the military forces, with his seat at Antigua. Governor Merewether was on the "Appam" when that vessel suddenly appeared at Newport News and was interned there. At the time of Governor Merewether's appointment, Colonial Secretary Best was made Acting Governor of the Leeward Islands to serve until the arrival of the new executive. As it turned out, however, he was destined to serve "for the duration of the war" with his wife and son kept in England on account of the U-boat menace.

We were entertained several times at Government House, where the Governor keeps bachelor quarters with his military aide and secretary, Captain Nicholson, who has lost a leg in the great conflict but does so well with an artificial one that we did not at first discover the true situation. Government House is a notably comfortable residence and guests are made most delightfully at home in an informal and therefore all the more satisfactory manner. The grounds are well laid out and there is a good set of tennis courts where this favorite English sport is indulged in by the experts of Antigua and neighboring islands.

Some of us happened to be staying at Government House when the cablegram announcing the initial success of the American troops on July 18th, the beginning of the great offensive that was destined to win the war, was received, and immediately read by His Excellency. At dinner there was the usual "toast to the King" which is proposed daily at every Government House in the British Empire, in which we very gladly joined on invitation. Before taking his seat, Governor Best raised his glass and proposed a toast to "The President of the United States," a tactful bit of courtesy that warmed the hearts of the American guests.

War conditions on the island did not seem to be felt so much as with us. At one time in the spring there was some scarcity of food owing to the non-arrival of a steamer, but at the time of our visit there seemed to be a fairly adequate supply. There

were no restrictions regarding food consumption, no tax on incomes so far as I could learn, and I believe there had been no conscription of men. Many of the whites had volunteered, however, and here, as elsewhere in the British colonies, the terrible price had been paid in bloodshed and in death. Dean Shepherd of the Anglican Cathedral and his wife had lost two sons, both in the aviation service, and she has since lost a brother. Here, as elsewhere in the islands, there has been extensive migration of the blacks to the United States. I was told by a colored clergyman that about thirty per cent of the Antiguanus were now in America and that many of them were doing well and sending money back home. I could not help thinking that most of these people would do equally well in Antigua if they worked as hard as they have to in order to succeed in the United States. Few of them can be induced to put in more than four days a week and they do not average that much. Six days' work a week would add fifty per cent to their income and make the difference between extreme poverty and reasonable comfort. It must be remembered, however, that steady work in the tropical heat of Antigua is more of a tax on endurance than it would be in our climate.

Of course our advent created considerable excitement, particularly among the negroes. They were, however, more universally friendly than the Barbadians and none of our party met with any evident hostility. To be sure many of them were unable to believe that our real object was the collecting and study of marine animals. The story was circulated that we had been sent out by the United States government to report on the advisability of securing English Harbor for the use of our navy. This idea grew luxuriantly until it was finally reported that we had purchased the whole island of Antigua as well as several others of the Lesser Antilles. Mr. Henderson's launch excited a good deal of interest and was regarded as something almost supernatural and a real marvel of speed. The engine being a smooth-running one, there was almost none of the ordinary noise of a gasoline motor, and this added greatly to the mystery of its movements in the eyes of the natives.

The writer was asked to address several meetings of various sorts and found the experience most interesting. The first

request was to speak before the Agricultural Society, where an intelligent and appreciative audience of planters and agricultural experts met in a room in the Government Building at St. John's. The chairman, Mr. Cowley, observing that the speaker was glancing at his watch in order to keep within a reasonable time limit, quietly captured the time-piece and insisted that I forget about the time,—a very delicate compliment, as it seemed to me. Then the writer was asked to address an annual missionary meeting at the Moravian Church in St. John's. I had met the pastor, Reverend Mr. Hutton on the "Korona" the year before and was glad to avail myself of the opportunity to meet his people. The occasion was one of more importance and dignity than I had anticipated. The Governor presided, accompanied on the platform by Colonial Secretary Watson and Captain Nicholson. The speakers included several negro clergymen, the Colonial Secretary, two white clergymen, the Governor and myself. The Reverend Mr. Haines (white) of the Wesleyan Methodist Church gave a first-rate address and the Reverend Mr. Belboda (colored) of the same church spoke with much force and a diction that would have done him credit before a metropolitan audience. The writer was impressed with the earnest bearing of the audience of perhaps a thousand black people and a half dozen whites. There was something inspiring in the absorbed attention of that mass of negroes as they listened to a stranger from that country to which so many of their fellow Antiguans had gone and from which such stories of abundance and prosperity had returned. And so I was moved to make my remarks along patriotic lines related to the great war, and found the audience instantly responsive to every expression indicative of the good-will and coöperation existing between Great Britain and the United States. I must confess that I thoroughly enjoyed the occasion, particularly when Governor Best concluded the speaking exercises by an address in which he spoke feelingly of the work of our expedition and of the debt that the people of Antigua owe to the United States, "whose citizens are literally denying themselves that we may be fed." When the financial report was read it was found that £118 had been raised, a very respectable sum when one considers the poverty of most of the contributors.

I afterward learned that my participation in this missionary meeting had resulted in a belief that I was a *Moravian bishop*, the very last personality that I had ever expected to be mistaken for and an honor of which I am wholly unworthy. As a consequence, however, I was the embarrassed recipient of many invitations to speak, all but one of which were declined with thanks. This was another missionary meeting at Grace Hill Church on Sunday afternoon. The church is most picturesquely located on the top of a high hill and the road leading to it was through one of the most charming tropical valleys that could be imagined; with little hamlets embowered in groves of palms and other tropical trees, the houses often being so small as to resemble toy structures with thatched roofs, the whole bearing an Oriental aspect much like pictures of scenes in the Philippines and Japan. The church is a very old one and from the yard one commands a view perhaps unsurpassed in Antigua, across the hills and valleys to the sea in the dim distance. The church was packed with a very attentive audience of black people in their Sunday clothes, which were spotlessly clean. Some of the women wore truly imposing hats with gorgeous trimmings perched on turbans that offered amazing combinations of bright color. The chairman was the same Mr. Cowley, President of the Antigua Agricultural Society, whom I have already mentioned. Reverend Mr. Balboda of the Wesleyan Church was the principal speaker and he again impressed me with his dignified bearing and an excellent practical address that would have held the attention of almost any audience. It is customary here for someone to move a vote of thanks to the speakers. Three of these were black and two white and it must be confessed that the latter were put on their mettle to hold their own in the forensic field. The congregational singing went with a vim and there was a very well rendered soprano solo. Over £20 was raised, which was pretty well for a people in this country district where most of them earn not more than a shilling a day. Religion seems to enter more prominently into the lives of these people than it does at Barbados. It is not so emotional as among the blacks of our southern states, and partakes rather of the British solidity and decorum.

The members of our party were temporarily parishioners of

the Rev. Hal Shepherd of St. Paul's Anglican Church. This is another old sanctuary with an ancient churchyard in which are many old tombs, some of them dating back over two hundred years. One morning when seven of our party attended the services the clergyman remarked that he had probably at that time the largest number of white people in his audience that had been present since the dedication of the church.

The Wesleyan Moravian, Anglican, and the Roman Catholic churches divide the field here, most of the whites attending the cathedral at St. John's. This is really an imposing edifice situated on high ground back of the city. The Bishop was absent during our visit and Dean Shepherd, father of the Rector of St. Paul's Church, officiated. There is a very interesting burial ground where some of the tombstones bear dates back nearly to 1600.

The Leeward Islands constitute a Crown Colony with the seat of government at Antigua. This island is one of the "Presidencies" and is governed by a Council of sixteen members, all nominated by the Governor, who is chairman of the Council. There is therefore no representative government as we understand the term. On the other hand, there is no established church.

Social affairs were not so prominent in the life of our party here as at Barbados, due mainly to the distance of English Harbor from the capital at St. John's, the only communication being by auto and the rates being rather too heavy for our purses except when business affairs necessitated the trip to town. A number of the more prominent people called on us at our quarters and we greatly enjoyed their visits, although we were unfortunately unable to return most of them. These calls were invariably made late in the afternoon after our daily work was about completed. The planters came in their own cars and at times quite a party would be gathered on the veranda, which occasionally looked like the scene of an afternoon reception, although unfortunately we could offer them little in the way of entertainment. We attended one affair which interested us very much. It was a Red Cross entertainment given by the high school girls under the direction of the Misses Branch. It was a high society function, attended by the Governor, the Col-

onial Secretary, and other officials, all in evening clothes. The performance consisted of a little farce called "The Anarchist" and then an allegorical sketch "The Hours" given by a group of very pretty girls representing Father Time, the Seasons, and the Hours. The costumes were extremely well designed and the performance one of the best amateur affairs that we had seen. Between the acts little girls in costumes representing different nationalities sold ices and fancy articles. We wanted to take some of these pretty little maidens with us as specimens, but the plan fell through. Red Cross teas were given every Friday at the Hotel Esperanza, and shortly before we left we were invited to an afternoon reception at Government House given for the benefit of the Red Cross fund, the Governor suggesting in his invitation that it would be a very good opportunity for our Antiguan friends to say goodbye and wish us a successful voyage. There was tennis as usual; and tea and other refreshments, both liquid and solid, were served in a pavilion on the grounds. It was quite evident that prohibition was not in force here; but it must be confessed that at no time did our Antiguan friends exhibit anything but an entirely temperate use of strong drink, although total abstinence was not the custom.

So far as we discovered there were no Americans in the island at the time of our visit. Neither was the United States represented by a Consul or even a Consular Agent. An occasional Canadian is encountered, and the Colonial Bank of London has a branch in St. John's which attended to money matters for our expedition.

Mr. Forrest, a local merchant, is much interested in geology and zoology and has gathered together quite a valuable collection representing the fauna of the island, which he is keeping in good shape and much of which is identified. We heard of several collections of shells, one of which we examined with interest. It is owned by Mrs. Branch and is a result of many years of collecting by her husband who died a number of years ago, and seems to be a fairly complete assemblage of West Indian mollusca from the littoral zone and shallow water. This collection is for sale and would repay investigation by anyone interested in securing a fairly representative series from

that region. The collector was evidently one of those born naturalists who linger affectionately over their specimens and handle them tenderly. This affection finds expression in a poem, a copy of which was presented me by Mrs. Branch, which shows a rare appreciation of nature as represented by sea shells.

The city of St. John's has a population of about 9,000 and faces the harbor of the same name. It is more regular in plan than Bridgetown, the streets being fairly wide, straight and usually at right angles to each other. On steamer day there is considerable activity, but ordinarily there are no crowds except around the market and an occasional Salvation Army meeting. Life seems to be of the usual tropical "dulce far niente" sort and there is much less of strenuousness than is evident at Barbados, because the struggle for existence is far less keen. The people show less aptitude for continuous hard labor. There are some good stores such as that of Forrest and Co., Harper's Drug Store and José Anjo's, where photographic materials, etc. may be obtained.

There are several commission firms which do a comparatively large business, such as Bennett, Bryson and Co., with whom we arranged for the sloop to move our effects to and from English Harbor; and A. J. Camacho and Co., agents for the Quebec line. Most of our groceries were secured from Mendes and Co. Although we found that there were some aggravating delays in delivery of goods, our business dealings were on the whole quite satisfactory.

About the only really imposing buildings at St. John's are the Anglican Cathedral and Government House. There are several other churches but they are not architecturally attractive. The lack of hotel accommodations already referred to is a handicap that will prevent visitors from stopping over between steamers, as would otherwise be well worth while.

There are many delightful auto rides out from St. John's, and Anjo's auto service seems adequate to the needs of the place and not unreasonable as to rates. The most interesting thing here, as in every out of the way place, is the people. Through the kindness of Colonel Bell, Mr. Ricker was given every facility for taking pictures to his heart's content, and as a result we have a pictorial record of the street scenes and daily

life of the native Antiguans both at St. John's and the country districts, that is as comprehensive as could be desired. Through the courtesy of the authorities, Mr. Ricker took a moving picture of a review of the Defense Force and Police Force that should prove highly interesting.

The vicinity of English Harbor is the most picturesque part of the island, as well as the most important from a historical point of view. On Sundays we devoted a part of our time to visiting such points as were within walking distance. One of the most interesting of these walks was to Shirley Heights and the "Ridge." A short ride in a rowboat took us from the Dockyard to the landing below Clarence House, which is reached by a road ascending rather abruptly. This house was built about the year 1786 for Prince William Henry, afterwards Duke of Clarence and still later King William IV. Of late years it has been used as a summer residence by the Governors of the Leeward Islands. A beautiful view of English Harbor and the surrounding country can be enjoyed from the front veranda of this house. Passing on up the hill behind Clarence House, an old government road offers an easy path to the Ridge, where one finds on either hand evidence of the naval and military structures, consisting of elaborate fortifications and accommodations for the considerable bodies of troops that were quartered there in by-gone days. Here is the ruin of a solidly built powder magazine. A little farther on are great catch-basins of solid masonry with immense cisterns beneath still holding quantities of water. A large hospital stood on the top of the ridge, but is now entirely in ruins. The officers' quarters is one of the most imposing of these buildings, the solid arches of the long stretch of veranda still being intact. There are ruins everywhere and the remains of great structures, even the names of which are known to few persons. Gun emplacements and fortifications are encountered every few minutes along the walk on the Ridge. Here were quartered at times many thousand troops and one can well believe from the extent of the ruins that there was no exaggeration in the story told me by an official to the effect that Great Britain had spent some £25,000,000 in and about English Harbor.

At the extreme end of the Ridge is a cemetery with a monu-

ment to the soldiers of the Leeward Islands; and tombstones, some of which are falling down, and all of which are in memory of the defenders of the British Empire. The 54th Royal Artillery has a number of its former comrades buried here, and this organization, like many others in the British service, has a long vista of traditions behind it and cherishes the names on the rolls of past times. Within recent years it has paid to have this cemetery cleared of the rank growth that so quickly destroys structures made by man in the tropics, and the graves of its members repaired. From the reading of the inscriptions it seems that a majority of the men were victims of yellow fever, which at times took fearful toll in this region, and died between 1850 and 1860.

The most prominent feeling that asserts itself in the mind of the writer when visiting such places is the sense of the futility of our efforts to perpetuate the memory of the individual who "struts and frets his hour upon the stage and then is heard no more." Less than a century has passed since most of these men were buried on Shirley Heights and yet the inscriptions are already hard to decipher on some of the stones. Many have fallen and the graves themselves are practically obliterated. Possibly a more practical reflection is the futility of expending large sums of money on fortifications and military or naval bases which are often doomed to fall into ruin without having served any useful purpose whatever. So far as I could ascertain, no hostile gun was ever fired at English Harbor or the surrounding fortifications.

To the north of English Harbor is one of the highest hills of Antigua, known as Monk's Hill, at the summit of which is a signal station from which approaching vessels are reported by telephone. The keeper has been on duty for something like twenty years, during which time he has been absent only a few days. The hill was also strongly fortified and extensive ruins are still to be seen. Our observations in this region inclined us to admit as reasonable the statement made by Algernon E. Aspinall in his "West Indian Tales of Old," p. 171:—

“In the entire chain of West Indian Islands there is no spot at once so romantic and so full of historic interest as English Harbor, which lies at the southeast corner of Antigua, the seat of government of the Leeward Islands.”

CHAPTER IX

HOMeward BOUND

We began packing our collection and equipment for the return trip on July 15th, the work being directed by Messrs. Stoner and Job, although all hands assisted. A few articles necessary for our quarters that had been purchased at St. John's were presented to the Defense Force as a partial return for the use of such of the equipment of the quarters as had been loaned us by their courtesy. Arrangements had also been made for the chartering of the sloop "Resolute" to take our effects to St. John's; and, as before, these arrangements were made through the firm of Bennett, Bryson and Co. The uncertainty of the time of the arrival of the Quebec Company's vessel "Parima" caused a good deal of annoyance. It seemed impossible to secure any information regarding the movements of the vessels, which was doubtless necessary as a war time precaution, but was nevertheless extremely aggravating to a party as large as ours. If our goods were sent away on the "Resolute" too soon, we had to pay for the time lost in waiting for the steamer; but it would of course have been much more serious to have the sloop come too late, as missing a steamer would have been simply disastrous, involving a delay of at least two weeks with our equipment and baggage shipped away on the sloop.

During the whole time of our stay in the West Indies the director of the expedition was haunted by a fear that something would happen to the steamer on which we were booked for the return passage. There were all sorts of rumors afloat. Many times we heard that the Quebec line steamers were to be commandeered by the Admiralty for the use of the Allies. The taking off of any one of them would have involved extremely serious consequences to the islands, and even severe food scarcity to their inhabitants. The margin of commissary supplies was a slender one at best, and with the responsibility of eighteen

persons on his hands the director was by no means happy in view of this possibility, particularly as the funds of the expedition were insufficient to meet even two weeks, unexpected delay.

Then, too, there were wild rumors of the activity of the submarines off the Atlantic coast and in the West Indies, and positive reports that one or more of the steamers had been torpedoed. As a matter of fact I felt much less concerned about the sinking of the ship with the expedition aboard than I did of its being lost before it took us from Antigua.

Another difficulty was in securing accommodations for our party at St. John's while waiting for the steamer and after our effects were placed on the sloop. This would not seem a very serious problem in a city of nearly ten thousand people anywhere else, but here it was really formidable. After the most strenuous pleading the best we could do at the one hotel, the "Esperanza," was a reluctant consent to take four of us with the understanding that one would sleep on the sofa. Room was found for six others at a lodging house. For the rest, we were reduced to the humiliating necessity of quartering ourselves on our good friends living in St. John's. Ultimately five of us accepted the hospitality of Government House, one was accommodated at the Deanery and one with Colonial Secretary Watson. These arrangements were understood to be for one night.

The date given for the arrival of the "Parima" was Saturday, the 20th of July. On the afternoon of the 18th the "Resolute" rounded Barclay Point and drew up along the sea-wall in front of our quarters, and the men of our party went to work with a will carrying the equipment and collections, which had all been packed on the preceding days, down to the sea-wall, where the men on the vessel took it in hand and stowed it away before night. We packed our trunks and other baggage, settled with the servants, and went to sleep for the last time in Officers' Quarters at the dockyard where we had spent so many never-to-be-forgotten days.

Early on the morning of July 19th we took down our bedding, which was to go on the "Resolute," and last of all put our trunks aboard. After an early breakfast Professor Thomas, Mr. Wehman and Willis Nutting went aboard and sailed away

with practically all of our belongings except a few satchels. As the sloop glided out of sight around Point Barclay those who remained could not help remembering the anxious nights when we waited in vain for her appearance on the occasion of our first arrival at the Dockyard.

She had not been gone a half hour when I received a cablegram from Mr. Lawrence, agent of the Quebec Co., informing me that the "*Parima*" *would not be in until Monday the 22d.* This was a pretty kettle of fish! We had managed to arrange for the accommodation of our party at St. John's *for one night only.* Our effects had been shipped off; the servants had been paid; the provisions had all been used, the last meal having been skillfully compounded of "leavin's." We telephoned to our much harassed friends at St. John's and to the hotel and rooming house. They all showed remarkable fortitude and stood up manfully under the unexpected blow. Governor Best rose to the sublime heights of hospitality when he said "It is our good fortune that you are delayed and can pass two extra days with us." Others did the same and we realized that the far famed West Indian hospitality was equal to any test, and contemplated it with awe and something akin to reverence.

At 9 o'clock A. M. the launch left for St. John's with Greenlaw, Mrs. Thomas, Miss Sykes, Miss Van Wagenen, Dr. Fisher, Mr. Ricker, and Mr. Ensign. The servants lined up on the seawall and waved hats, bandannas, and aprons in a hearty farewell, as the "*Eolis Jr.*" glided around Point Barclay and out to sea. Mr. and Mrs. Stoner, Dr. and Mrs. Job, and Miss Mullin had already slipped away in an automobile.

My wife, son Carl, and I were thus left alone to look after the last things that someone always has to attend to. The servants had dealt faithfully with us and it was fitting that they should be tipped as they had already been by most of the party, and we gave them something as a reward for their fidelity. Some of them had already given the ladies of our party presents of articles made of seeds greatly resembling the bead-work of our northern Indians. Such of our clothing as it seemed unnecessary to take home was gratefully received by the servants.

Mr. Lake, the caretaker, had spent much time in helping us to settle our various accounts with the servants and Mr. Potter, and had declined to charge anything for his services. A little token of appreciation in parting, however, it was entirely fitting that he should accept. Corporal James was on duty at the dockyard during our entire stay and had helped us with a hearty good will on several occasions; and the aged gate-keeper, Page, had been a faithful warden and always appreciated the joke when we gave him the password "Indianapolis."

The car came for us about noon, the servants waved their last farewell, the gate-keeper hobbled out and opened the ponderous gate and stood waving his hand as we passed. I must confess to a feeling of reluctance in leaving this historic spot which had been our home for four weeks, and the simple and good-hearted people who had tried so hard and so successfully in the main to accommodate their services to the strange and often to them unheard-of customs of the people from Iowa, a place that was as unknown to them as English Harbor had been to us two years before.

As our car speeded through the village of English Harbor the people stood in their doorways and waved us a hearty good-bye as did many of the other villages along the way. Arriving at St. John's we found that the sloop had had a fair wind and had beaten us in and our party had already distributed itself according to arrangements.

At Government House we were very comfortably situated; and the luxury of well appointed rooms, well drilled servants and a hospitality that was so genuine and tactful as to make us forget that we had in a way been thrust upon our generous host, Governor Best, was very grateful after the rather strenuous life at English Harbor. It was a relief, moreover, to escape from the perpetual high wind that had blown so incessantly at the Dockyard as to "get on our nerves" to quite appreciable extent. That afternoon we attended a Red Cross reception given on the grounds of Government House, where we met many of the more prominent citizens of Antigua, with most of whom we had already become very pleasantly acquainted. As the Gover-

nor had suggested, the occasion served as an opportunity to bid the members of the Barbados-Antigua Expedition a kindly farewell.

The next day, Saturday, July 20th, was devoted mainly to small matters of business and in calling on some of the officials, particularly Colonel Bell and Captain Downing, who had done everything in their power to aid our expedition, and Mr. Colless, who had given much of his time to such good effect. In the afternoon His Excellency took us on a delightful automobile ride along the west coast and through some beautiful inland valleys that we had not seen before. In the evening we attended the entertainment given by the high school girls under the management of the Misses Branch, which has already been described. We Americans were in a particularly good humor over the cablegram received that afternoon which announced the initial victory of the United States troops in France.

On Sunday some of us attended service at the cathedral conducted by Dean Shepherd. Most of the officials and white residents of the city attended here. In the afternoon we took tea with Dean and Mrs. Shepherd at the Deanery, where we met once more a number of friends. In the evening we sat out in the moonlight on the lawn in front of Government House with the Governor and Captain Nicholson, which made a quiet but exceedingly enjoyable last evening in Antigua.

We were up early in the morning on July 22d, as the "Parima" was expected at about 7 A. M., although she did not get in until 10. We said goodbye to our host and were taken in his auto to the dock, accompanied by Captain Nicholson. All of our party were soon on hand and we boarded the sailboat (the government launch being out of commission) with all of our hand baggage and a number of other passengers. Many of our friends were at the wharf, and as we glided away we gave "nine rahs" for Antigua and they responded with the "Hip! Hip, Hooray!," which is the British equivalent. With a fair wind a few minutes' sail brought us alongside the steamer and we were soon aboard and settling in our staterooms. The "Resolute" was already at hand and our collections, equipment and trunks were quickly transferred, all being taken as baggage according to the generous agreement made with the Quebec Co.

This concession not only saved us considerable expense but also almost unlimited annoyance and vexation in making out bills of lading and in fulfilling the almost impossible requirements attending the shipment of such a conglomerate assemblage of items as freight under the perplexing regulations of the War Trade Board at that time in force.

As director of the expedition, the writer keenly felt the responsibility of such an undertaking in war time and it was with a feeling of unspeakable thankfulness and relief that he realized that the scientific work had been completed, the collections and equipment were on board, and every member of the party in excellent health and enthusiastic over the success of the Barbados-Antigua Expedition. The responsibility of the voyage now rested with Providence and Captain Gladwin of the "Parima," and thus a tremendous weight was removed from my shoulders and I was prepared to enjoy myself thoroughly as a passenger.

Of course the U-boat menace had still to be met, but we were not greatly worried about that. The chances of disaster to any particular vessel were almost negligible when we considered the number lost as compared with the many hundreds that daily passed through the danger zone in safety. The fact that the vessel mounted a three-inch naval gun above the after deck and carried a couple of naval gunners added something in the way of safety; although it must be confessed that we had a feeling that in case of actual attack from a submarine, many of which carried six-inch guns, the defense offered by the "Parima" would be an actual element of danger, as it might not unreasonably serve as an excuse to sink without warning. Then, too, the fact that we were to be loaded with sugar and averaged not much more than nine knots an hour would make us an easy prey should we be sighted by an enemy. Although we realized all this, it must be said that there was little uneasiness manifested by the members of the party, and we were too thankful to find ourselves homeward bound to worry very much about remote contingencies.

We made St. Kitts late that afternoon, but our stay was too short for any one of us to go ashore, a fact which I regretted, especially as an officer came aboard with a courteous invitation from the administrator, Hon. Maj. Burton, to visit him at Gov-

ernment House. Dr. Van Horn, the ship's surgeon, who had been on the "Korona" when I returned on her the year before, was at the head of our table and added much to our pleasure by his courtesy and genial friendliness.

We reached St. Croix about 11 A. M., Tuesday, July 23d; but no one went ashore. At no place that we visited were the port regulations so needlessly aggravating and apparently without rhyme or reason as at the first American port visited on our return voyage. That a party of United States citizens, constituting a scientific expedition accredited by the State University of Iowa, our Secretary of State, the British Ambassador, the American Consul at Barbados, with passports in proper form and no bombs about their persons should be refused permission to take a short stroll ashore by the exceedingly self-important young officers who came aboard at Basse Terre, St. Croix, is but one additional illustration of the disastrous psychological effect of a little brief authority.

After leaving St. Croix we had our first life-boat drill and were impressed with the necessity of this precaution, which should be enforced on every vessel going to sea, even in times of peace. A comparison of our first drill with one of our last ones shows how great the saving of life would be if it were universally practiced. We were all given tickets assigning us to the boats which were swung out-board. At the sounding of the alarm, which was the rapid striking of the ship's bell, all were supposed to get their life-belts and take their positions as quickly as possible beside the boats. There were three occupants of the stateroom in which I was quartered, and there were but two life-belts and one of these had broken straps and would have been almost useless in actual service. There was a good deal of confusion, a number of people not understanding how to put on the belts or what they were expected to do. When all were assembled each officer in charge of a boat saw that everyone was in his place and that each had a life belt properly inspected and *fitted* before he was allowed to leave for his stateroom. In one of the later drills, the alarm was entirely unexpected and every person was at his place beside his boat with life-belt on and properly adjusted, inside of *one minute!* There

was no confusion and I am satisfied that there would have been very little had we been really attacked.

Of course, after the indolent American fashion, we will forget all of this now that the war is over. The life-boat drill will be regarded as a nuisance by the officers of passenger vessels and will be gradually relegated to the realm of good intentions and forgotten until some new disaster will call it to mind and we will pass laws to be enforced until the excitement is over and then forget again *ad infinitum*. If we only could learn by experience! But we can't. At least history shows that we don't.

That evening we made Charlotte Amalie, St. Thomas, just after sundown and spent the evening in the quiet harbor encircled by the lights of the town; more lights, by the way, than we had seen at any one time since leaving New York. Here also we were refused permission to go ashore, although we would have been glad to visit Dr. Nies, he of the picturesque Blue-beard Tower, and our old friend, Dr. Butler. Passengers who came aboard brought news of the renewal of the U-boat raids off the Atlantic coast, which did not add to the pleasure with which we contemplated an approach to the city of New York. At the same time, however, we heard good news of a successful drive of the Allies and Americans in France which helped our feelings very materially.

The next morning found us steaming along the northern coast of Porto Rica, having had orders to call at San Juan for as much sugar as the vessel could carry. Of course we welcomed this variation in our schedule that would enable us to visit one of the larger West Indian islands and one as different as could be imagined from those of the Lesser Antilles. We were told, however, that in all probability we would not be allowed to go ashore and our experience in the American possessions just visited was far from reassuring on that point.

The morning was bright and the sea smooth as we neared the approaches to San Juan Harbor and there was every sign of the environs of a first-class city as viewed from the sea. With a background of a serrated mountain chain and a foreground of deep blue sea, the setting of San Juan is ideal from an artistic standpoint. As we approached the harbor encampments of

Porto Rican troops could be seen, with long rows of khaki colored tents and level parade grounds. Then substantial stone buildings, a huge wireless plant, pretty villas, and the fortifications guarding the magnificent harbor, chief of which looms up the famous Castle Morro with its lighthouse. The whole sea-front here was exceedingly well fortified and the system of bastions, moats, battlements, etc. is still most picturesque and a fine illustration of the old style of city defenses in the time of Spanish glory. Doubtless the modern defensive system is adequate, although not in evidence.

Soon the little pilot boat with the beautiful American colors comes dancing over the waves and the "Parima" passes cautiously through the narrow channel and into the famous harbor of our largest West Indian possession, steaming between the Morro and a little fortified island, Carmelo.

The water-front as seen from the harbor is quite metropolitan in appearance. Many handsome stone buildings several stories in height make an imposing skyline in comparison with that of other cities visited during our cruise, and the extensive wharves and numerous vessels from various parts of the world attest the maritime importance of this great island port.

All of which made us exceedingly anxious to land, and this anxiety grew momentarily more intense as the customs officials came aboard. The officer in charge, however, was a man of more experience and authority than those whom we had encountered in the Virgin Islands and actually took the time to consider our arguments instead of giving an abrupt *a priori* refusal, which was the method of the Virgin Island officials. After an inspection of passports, the much desired permission admitting a party of American citizens actually to step ashore in an American port was issued, and even Mr. Ricker was allowed to take his camera and put in a most successful day of photographic work.

We found at once that San Juan is still a Spanish city in every way, but spurred on by American enterprise in the erection of a number of modern and imposing buildings. Great warehouses on the wharves were piled to the roof with thousands of tons of sugar awaiting shipment to the United States. Here was the world crying for sugar, the American people put

on short allowance; while in an American city only a few hundred miles from New York there were mountains of sugar! Never before had we realized that the problem was not so much one of production as of distribution. There was probably at that time more sugar in the world than ever before and still the world was starving for sugar. It was hard, moreover, to inhibit the idea that a slow merchant ship loaded down with sugar would be a toothsome morsel for an enterprising U-boat captain.

In such a brief visit as ours nothing but the most general impression can be secured. The city seemed quite metropolitan in comparison with those of the Lesser Antilles. Many of the buildings are architecturally imposing, having been built since the island became American territory. The old part of the city is characteristically Spanish with narrow streets and the little iron balconies so familiar in Havana, for instance. There is an excellent electric railway system with up-to-date equipment and service and we saw several fine plazas such as Plaza Colon with a statue of the great discoverer after which it was named, the Plaza San José with a huge statute of Ponce de Leon, and a beautiful park with a long walk fronting the sea and under an avenue of palms. In one respect the city is far from typically Spanish, and that is in its sanitary arrangements, street cleaning and water supply, all of which accord with the most modern ideas; and the fine public school buildings are such as I never saw in a really Spanish city.

The thing that strikes the visitor most forcibly, however, is the little impression made by almost twenty years of American occupancy on the language and customs of the people. Of course one expects the Spanish tongue to preponderate, but he also expects, and not unreasonably, that the public official should have some knowledge of English. The customs officer who remained on board the "Parima," a British vessel bound to New York, did not seem to know a word of English, and the same is true of the uniformed police and street car conductors.

Some of the younger members of our party found compensation in the way of the discovery of real American soda fountains and that idol of our national youth, ice-cream soda! After having been deprived of this beloved beverage for some months, they rushed for these refreshments and fairly revelled in long-

deferred delight. To be sure, the milk used was condensed milk, but that proved a very fair substitute. Moreover it was gratifying to our patriotism to find that whether the constitution followed the flag or not, the soda-water fountain did.

There were a number of really first-class stores stocked largely with goods from the United States, where some of our ladies shopped in quite a satisfactory way in spite of linguistic obstacles. The latest New York paper that we secured here was the "Times," dated July 10th and therefore just two weeks old. There were several showers during the day and after a few hours of sightseeing most of us returned to the ship, where we were under shelter, at least; although the racket of the hoisting engines used in loading the countless sacks of sugar was anything but soothing. We also coaled here, but the method was entirely different from that in such a port as Santa Lucia, for instance, where the vessels were coaled by women carrying baskets of coal on their heads in endless procession, each dumping her load as she passes the chute, thereby raising a cloud of dust. At San Juan the collier came alongside and an endless chain of buckets issued from her hold and were automatically emptied into an iron tube resembling a smoke-stack, the force of gravity conveying the fuel to the hold, which was so well covered that little coal dust escaped.

We went to a movie in the evening and saw a good patriotic picture with excellent presentations of battle scenes in France. All of the legends were in Spanish of course, and the writer was expected to interpret, there being a tradition in the party that he knew that language. He probably hit it right part of the time. The Star Spangled Banner was played at the end of the performance, but it is not certain that the audience would have stood up had it not been for our prompt example, although it would be but fair to give it the benefit of the doubt. On mentioning our surprise that the English language seems to have made so little progress here I was informed by one man that although he had learned English in school, he found it so little used in business and social life in Porto Rico that he had almost no use for it in a practical way and therefore had forgotten most of it.

We tried to learn something of the attitude of the people toward the United States and America and our impression was

that the Spanish element, although polite enough to visitors, really was deeply resentful in view of the American occupation of the island. This is, after all, what might be expected of an intensely conservative and proud people in spite of the extraordinary material progress and prosperity which have followed in the wake of American military success.

Some time in the middle of the night the steamer quietly left her dock and stole out to sea without a light showing, and commenced her six-day run to New York. No land was in sight when we got up on the morning of July 25th. The weather was fine with a moderate sea and a breeze astern. Under these conditions our party suffered little from seasickness and we soon fell into the regular routine of sea life, resting, eating, and sleeping most of the time. A committee was appointed to get our accounts of the finances of the expedition in good shape before reaching New York.

We found our skipper, Captain Gladwin, unusually genial and greatly enjoyed his acquaintance. He was most considerate in keeping the director of the expedition informed regarding the advices received by wireless concerning the movements of the U-boats operating off the American coast. Our government seemed to be pretty well posted regarding their whereabouts and probable intentions. The Captain also gave me the foundation for certain stories that had been current in Barbados, one of which was the effect that all passengers had been ordered off the "Guiana" when at St. Thomas bound for New York. The facts were that a certain passenger and his wife had become unduly alarmed over the submarine menace and voluntarily went ashore at St. Thomas, made their way to San Juan and took passage to New York on the ill-fated "Carolina" of the Porto Rican line which was the only passenger steamer in the West India-New York trade that was sunk during the whole course of the war!

The writer has an immense personal respect and admiration for the captains of the merchant marine and their conduct during the great war. There were thousands of gallant men engaged in carrying munitions, food and other essentials through the war zone to our Allies on the other side. Many of them commanded ships that had long ago been condemned as unseaworthy, and crews that were undisciplined and picked up without any chance

for careful selection. Nearly all of the usual safeguards of sea service were wanting. No lights were allowed, neither the sounding of whistles in the dense fogs of the North Sea or the English Channel. The use of wireless was forbidden except in case of actual disaster and even in case of dire extremity the chances were that no ship would heed the S. O. S. call; for it was frequently used as a decoy by the assassin submarines. I know of one skipper who made twenty-four round trips from New York to Europe before they "got him," and even then he escaped to try it again. The captain of a passenger vessel has a grave responsibility at all times, but how terrible a load in such a war as that just ended few can appreciate. This service was fraught with much more danger than was faced by captains in the transport service; for the latter were regularly convoyed and every device used to guard from attack, and so successfully was this done that our loss of transports was practically negligible, while hundreds of merchant vessels were sunk.

And yet I have still to hear of a single one of these captains of the merchant marine showing cowardice or anything but admirable coolness and bravery even in the deadliest peril. The public at large knows little of all this; but I for one take off my hat to these fearless and competent skippers who have had no mean share in winning the great war, which will, please God, forever banish the sub-sea pirate from the Seven Seas.

Boat drills were frequent on the steamer. Our party was divided among four of the boats and I requested one of our men in each to be responsible for the members of the expedition in his boat. It was particularly gratifying to note the careful manner in which these boats were overhauled by Captain Gladwin, who personally saw to it that everything was in place and in good condition. Of course all boats were swung outboard during the trip and it was evident that the officers had neglected no precaution that would add to the safety of passengers in case it became necessary to abandon the ship. All of the officers were instructed in the handling of the naval gun so that they could serve it in the event of the regular gunners being disabled.

One might suppose that all these precautions and unusual proceedings would tend to make the passengers nervous, but the result was quite the contrary. The passengers were greatly reas-

sured and the voyage more than ordinarily enjoyable. For one thing, the spice of common danger served to intensify the *camaraderie* of all on board and there was more real sociability and good fellowship than I had ever before seen on a passenger vessel, and I am confident that they would have behaved well in the event of an attack.

On Friday the 26th we were making slow time on account of the gentle breeze astern, just about keeping pace with the vessel, resulting in a practical calm and insufferable heat in the engine and boiler rooms. Several of the stokers were laid out and the others were unable to do efficient work. In the afternoon, however, we had a sharp rain-squall accompanied by a brisker and cooler breeze that helped matters considerably. The hours between supper and bedtime were the most depressing and several members of our party were asked to give talks on our experiences, in the dining saloon, where a single shaded light was permitted. It was hard, however, to address people in the semi-darkness and most of us feel singularly helpless when we cannot see the faces of our auditors upon which we perhaps unconsciously depend largely for inspiration. I doubt if these impromptu lectures did very much to dispel the gloom, although they may have helped somewhat to pass the time. Professor Thomas discussed the geology of the islands where we had worked; Mr. Stoner told of his experiences as a bug-hunter in the tropics; Ricker explained the mysteries of the moving picture camera; and the writer told of our expedition as a whole.

On Saturday, July 27th, we received the first wireless news from the war and were rejoiced to learn that the great drive of the Allies was still progressing and that an important victory was claimed by the London papers for the French and American armies. We were passing through a very unfrequented stretch of ocean and saw no vessels of any kind for three days.

On Sunday it was raining and we had a song service in the saloon. Someone started "America" and about half the passengers sang "God Save the King," the music being the same for both. By noon we were about in the latitude of St. John's River, Florida, but several hundred miles to the east. On Monday we had wireless notice of submarines operating off the Atlantic coast

of the United States but considerably to the east of us and between Bermudas and Halifax. There was also more good news from France.

One of the passengers was a woman claiming American nativity but who has travelled very widely and whose husband is a Frenchman living in Martinique. She impressed one as more distinctively French than American. Her description of the manner in which the British and American armies were regarded by the French people was quite illuminating. She declared that when the British army came to France, it said, in effect, "We know all about this business. Just let us attend to our part of the line and you can attend to yours." When the Americans came, however, they said, "We don't know a darned thing about war. You show us and we'll catch on!", which seemed to take well with the French people. This same woman was in Athens when King Constantine was deposed, and gave us an exceedingly graphic description of the stirring events of that time. She said that she never saw such abandonment to grief as the partisans of the King displayed when he left.

About 8 o'clock in the evening we made out lights on the American coast and were certainly glad to see them, although realizing that running without lights in the path of numerous coastwise vessels we were really in more danger than we had been from the submarines. What the sailors dread more than anything else is the dense fog that often shuts down off the coast, the danger being intensified by instructions from the Admiralty not to sound whistles in case of fog. Thus, although we were nearly out of danger, the last hours of the cruise were after all the most anxious ones.

Early the next morning we passed Diamond Shoal Light and were off Cape Henry a little after lunch time. Wednesday, July 31st, was rainy and disagreeable, with a strong northeast wind, but all of us were happy in being so near the coast where we felt comparatively safe. Many vessels were sighted and there were some weird designs in the way of camouflage. At dinner I was requested to read the following, written by Madame Zourna Magny and signed by practically all of the first-class passengers:

"S. S. Parima, 31st July, 1918.

To Capt. C. M. Gladwin,—

"Simply an Old Grey Boat, tired and ready to rest, but animated with a Will that carries her over the course light and steady.

"In torrid waters in full security we who there felt as though we were in the hands of a kindly fate, and now that we are leaving the dangerous waters behind us, now that we are coming to port safe and happy, we all want to thank the Captain, the *Will* of the Old Grey Boat, whose kindly smile has made a trip in war time a thing of joy."

Captain Gladwin impressed us as exceptional in the fact that he bestowed his geniality on all alike and not upon a chosen few as is so often the case, and was on that account unanimously liked and admired. A collection was taken up for the naval gunners who had faithfully and literally stood by our gun during the voyage and would have doubtless acquitted themselves as befitted British tars had occasion required. Their huge embarrassment when being eulogized by the party who presented the purse evidenced a state of mind more agitated than would have been caused by the appearance of a submarine.

Shortly after dinner it cleared up, affording a delightful run in after we had taken our pilot. Newspapers were eagerly read and gave glorious news of the continued success of the great offensive inaugurated by the Allies just before we left Antigua. A sausage-shaped balloon hovered over the entrance to the channel. Darkness came on before we dropped anchor at quarantine, and the myriad lights of the harbor, Coney Island and the great city twinkled a benediction; and for the first time during the cruise the deck lights were ablaze and the port-holes unshaded. I sat late on deck that night, too happy to go below. The expedition had returned without mishap of any kind; every member was in excellent health and our collections and equipment were with us. I had hardly dared hope that the good fortune that had attended the Bahama Expedition twenty-five years before could be duplicated in the case of the Barbados-Antigua Expedition, and it was with a heart full of gratitude to a beneficent Providence that I went below and turned in without retaining a considerable portion of my clothes, without placing my life-belt where it would instantly be at hand, with-

out hanging my coat inside my slicker, without seeing that all of my money and most important notes were in my pockets, with God's free air coming in through an open port—and slept soundly with no fear of submarines. It was certainly "a grand and glorious feelin'."

The quarantine officers came aboard early in the morning of August 1st and made short work of their duties. We were surrounded by quite a fleet of vessels that had arrived during the night and New York Harbor never looked so beautiful to us as it did on that wonderful bright summer morning. The majestic figure of the Goddess of Liberty seemed to smile a welcome home as we steamed by, and in the golden glow of the rising sun the great metropolis was beautiful as a dream of Paradise. The "Parima" reached her dock about 9 A. M. and Henderson had managed to evade the strict regulations and was there to welcome us, so that our original party was once more complete.

We had, of course, a vexatious time in getting our things through the customs. The overworked officials were plainly irritated at sight of our miscellaneous effects that appeared as baggage, and had little patience in listening to our explanations. They lacked the courteous bearing that we had encountered in foreign ports, paid little attention to our credentials, and insisted that every one of our eighty-odd packages, barrels, boxes, soldered tanks, etc., should be opened for examination. Unfortunately I was unable to get in communication with the higher official with whom we had arranged matters on the outbound voyage. To open all of the packages, particularly the large number of soldered receptacles for the collections in alcohol and formalin, was out of the question, and we finally decided to send all of the University property through in bond to Des Moines and deal with the authorities there. This involved considerable expense and delay, but seemed the wisest course to pursue, although it was about a month before our collections were at last safely deposited in the Hall of Natural Science of the State University of Iowa. Telegrams were at once dispatched to President Jessup and by him relayed to various anxious friends who had as a matter of fact worried more than we

had over the submarine threat. That evening I received a wire from President Jessup saying, "All Iowa rejoices in your safe return."

Upon landing, the expedition disbanded as an expedition, and the responsibility of the director for its members came to an end. Although the carrying on of this enterprise in war time involved a good deal of anxiety and much annoyance and perplexity so far as our American regulations were concerned, it did not in any way interfere with the success of the expedition while we were in the islands. There we were treated as guests by the Colonial officials and it may be that we were the recipients of even more than ordinary consideration and courtesy on account of the war and the appreciation of the British authorities for the effective way in which the United States had at last thrown her whole energies into the great conflict.

The collections have been unpacked and found to be in excellent condition. As is usually the case, they seem to be more extensive when inspected as a whole than they did when being gathered together, and I am sure that as the various groups are worked up into the technical reports by the specialists who are to study them, their importance and extent will prove to come up to the expectation of all concerned. The following groups have been assigned as indicated below:

The reef fishes, Dr. Barton W. Evermann, Director of the California Academy of Sciences;

The pelagic and tide pool fishes, Dr. Charles H. Gilbert of Leland Stanford Jr. University;

The brachyuran Crustacea, Dr. Mary J. Rathbun of the United States National Museum;

The macruran Crustacea, Dr. Waldo L. Schmitt, United States National Museum;

The Asteroidea and Holothuroidea, Dr. W. K. Fisher, Director of the Hopkins Laboratory;

The Ophiuroidea, Dr. Austin H. Clark of the United States National Museum;

The Echinoidea, Dr. Hubert Lyman Clark of the Museum of Comparative Zoology;

The Crinoidea, Hon. Frank Springer, East Las Vegas, N. Mex.

The Mollusca, Mr. John B. Henderson, Washington, D. C.

The Annelids, Professor Aaron L. Treadwell of Vassar College;

The Actinians, Miss Gertrude Van Wagenen, State University of Iowa;

The Alcyonarians and Hydroids, Prof. C. C. Nutting, State University of Iowa;

The Pentatomoidea, Dr. Dayton Stoner, State University of Iowa;

The Foraminifera will probably be reported on by Mr. H. J. Wehman;

The geological report, Prof. A. O. Thomas, State University of Iowa.

The writer has greatly enjoyed the preparation of this narrative, recalling the numerous events of one of the most interesting and profitable experiences of his life as a naturalist. He finds that pleasant memories far outweigh the annoyances and perplexities that are woven together in the fabric of his story, the few sombre shades serving but to accentuate the brighter tints. It is an unusual and highly enjoyable experience to gather up the material that has been embodied in the zoological notes, and to roam as a free lance in fields apart from his own little corner of the science that treats of animal life. The specimens themselves recall the delightful environment in which they were found. To see things as they are in life with their proper surroundings; to be permitted to know them as sentient beings and not merely as museum and laboratory specimens, that are at best but the dead semblances of their real selves, is much to the zoologist. I still feel that the field naturalist has joys unknown to the laboratory worker and that he alone becomes truly acquainted with the real things in the living world. The occupants of a morgue are interesting, it is true, to the anatomist and pathologist, but how much more worth studying are human beings as living and active members of the social aggregation known as mankind. I therefore prize most highly the opportunity afforded by the Barbados-Antigua Expedition to roam at will over the greater part of the zoological field as represented by animal life in the tropics, and afterward

to study and at times dissect the rich harvest of the cruise. It has been my privilege to note the high lights, to stop for a more careful examination of particularly interesting forms and at times to look into their mechanism and make little discoveries that have the charm of novelty for me, although they may be known to specialists. To the teacher of zoology such an experience is of inestimable value. I have been impressed for many years with the fact that we can teach more effectively about those things that we have seen and studied alive in their proper environment, supplemented by laboratory work and the facilities afforded by a good zoological library.

I feel strongly impelled to make an appeal for more general field work on the part of teachers and am sure that the authorities of universities and colleges will make no mistake in devoting a very considerable portion of their appropriations to such expeditions as I have herein described, thus affording a life-long stimulus to their instructors.

I am grateful, too, to the members of the expedition who trusted themselves to the guidance of the director and loyally supported him, even at times when he may have seemed arbitrary and cranky. The trip was accompanied by unusual perplexities and anxieties, sometimes dangers, and we would have been either more or less than human had we not occasionally been "set on a hair trigger" and about ready to explode. That there was no real explosion is to the credit of all concerned.

None of us will ever forget the delightful way in which Henderson smoothed out ruffled feathers with his unfailing good nature and optimism. He is one of those fortunate persons who always seem able to stroke people the right way and dispel the grouchiest kind of a grouch.

To the members of the executive committee, Thomas and Stoner, we owe much of our success. Thomas was simply "a fiend for work," reliable and loyal to the core. His good nature was all but impregnable and more than one of us felt a huge unholy delight when once he showed himself human after all and almost wrecked an unoffending inanimate object instead of us who had tried him beyond the limit. We are all hope-

lessly in debt to Stoner, the right-hand man of the director and general utility man for the expedition at large. His was the most vexatious and thankless job of all, that of treasurer to the party. He it was who attended to the paying of commissary bills and collecting assessments from the party. We know that he saved us many a dollar by his painstaking and methodical care in keeping the accounts straight and securing justice for all with whom he dealt, whether the great commercial concerns at Barbados or the natives who brought their produce to our door. No man could discharge the trying and often irritating duties more conscientiously than did he. He also saved himself from the superman class by exploding just once, and, as Mark Twain said of the unsuspecting spider that stepped on a red-hot stove lid, "First a moment of awful surprise and then he [we] shrivelled up!"

Fisher was the most expert and thoroughly equipped collector of marine invertebrates in the party and much of the completeness and excellent condition of the collection is due to his suggestions and industry. As our advance agent at Barbados he performed a service that saved us much valuable time and provided well for the comfort of the party.

To the married ladies fell the greater part of the burden of our domestic comfort and dealing with the servants of which they, like the ghost of Hamlet's father "could many a tale unfold." To Mrs. Nutting, Mrs. Thomas, Mrs. Stoner, and Mrs. Job we are indebted for three meals a day and an adequate food supply to keep up the health and strength of the expedition.

None of us can ever forget the loyalty and energy with which Dr. Job worked at his laboratory and in collecting material of all sorts, both for immediate study and for shipment home; nor the enthusiasm with which Ricker pursued us and the natives with his various cameras and took movies of everything from the ceremonies in celebration of the King's birthday at Barbados to the antics of holothurians and land-crabs; nor of the skill with which Greenlaw managed the launch in dredging or concocted soursop drinks or crayfish salads.

Neither will we forget Miss Sykes, the irrepressible advocate of woman's rights and coxswain of the launch, the most fearless

sailor of them all; nor Miss Van Wagenen watching over her beautiful collection of living anemones and experimenting tirelessly to preserve them in good condition; nor Miss Mullin, whose affections were fixed on bottles and pans of wriggling worms, and who enlisted all the able-bodied men she could commandeer to pound coral rocks for the host of annelids concealed therein.

No one in Antigua will forget Wehman, the man who was lost in the awful storm on Sugar Loaf Mountain, nor will we forget his industry in collecting and sketching all sorts of sea "critters." The undergraduate members of the party, Dwight Ensign and Willis Nutting, did their full share of the work and were responsible for the collections of crustaceans and fishes, besides making themselves generally useful. Willis Nutting also did what little was accomplished in the way of botanical collecting.

Finally, that no one be unmentioned in this last roll-call of the expedition, it is but just to say that the youngest of us all, Carl Nutting, was entirely conscientious in the discharge of his duties, particularly at meal-time when he performed as official conch-blower to assemble the party for the important functions attended to in the dining room. At other times he was eminently successful in keeping out of everyone's way.

Fortunately, the director was not called upon to say goodbye to most of his companions at the termination of the trip, but meets them as colleagues in the daily task of teaching the boys and girls of Iowa. They, as well as he, have received an inspiration that will, I am sure, express itself in terms of better service.

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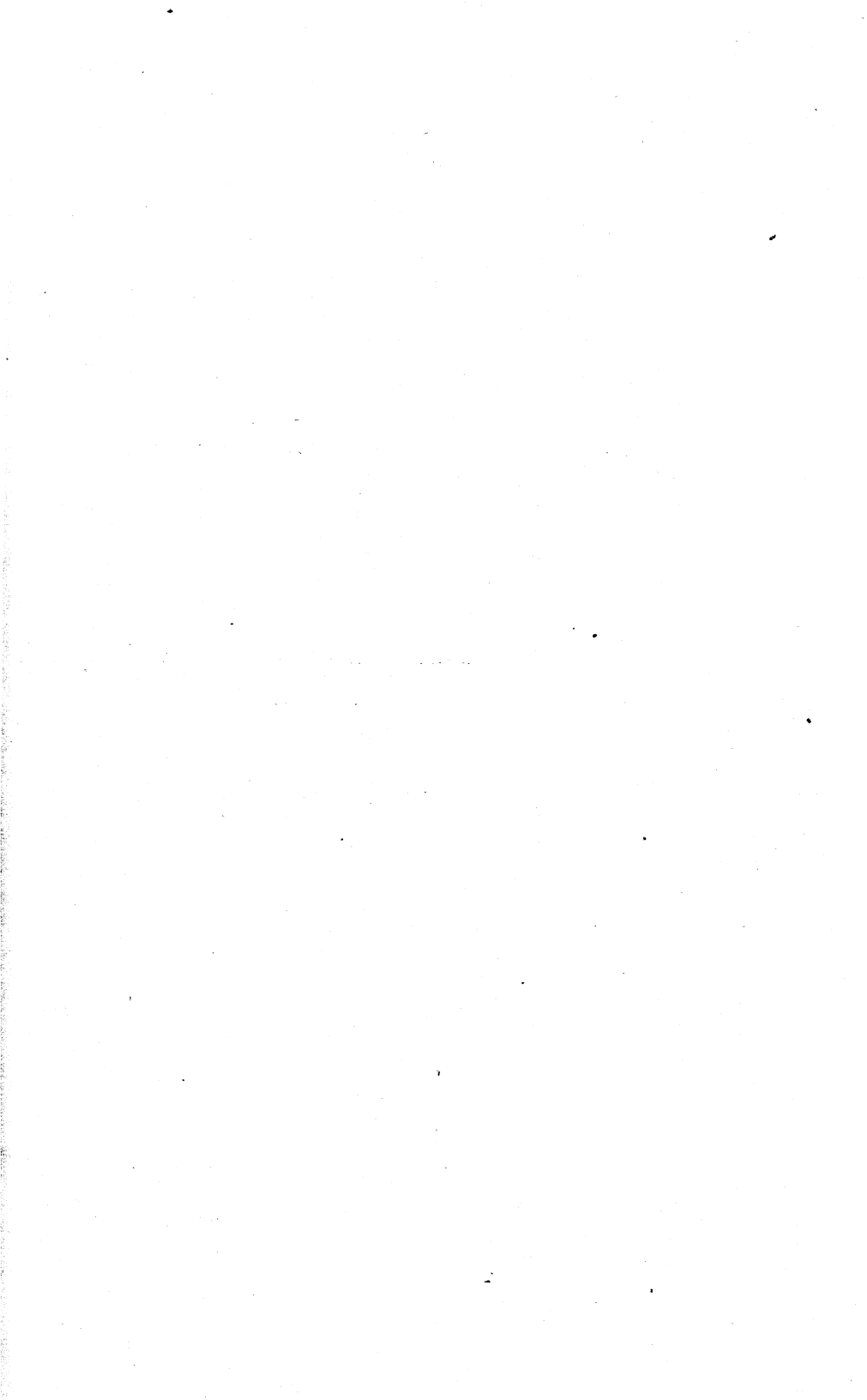
THE SCUTELLEROIDEA OF IOWA

by

DAYTON STONER

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PROFESSOR CHARLES CLEVELAND NUTTING, M. A., Editor

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INTRODUCTION

The object of the present work is to indicate, as far as possible, the status of the superfamily Scutelleroidea in Iowa, giving locality records, with notes on abundance, distribution, ecology and food habits of the species known to occur in the state. Diagnoses of the various groups are also given as well as tables for determining the species. Attempt has not been made to give complete synonymical tables for each species, although for some forms the synonymy is practically all included. It has been the aim to cite all the combinations under which each form has been known but names cited in error are not all mentioned. In most cases sufficient synonymical references are given so that a complete list may be made from the literature cited.

The descriptions are written from specimens themselves in connection with the original description wherever possible. They are intended to be principally diagnostic. Measurements are given for each form and they are taken in the following manner:

Total length.—Distance from apex of head to tip of wing membrane.

Width across pronotum or *Width across humeri*.—Distance across pronotum at widest point.

Following the description of each species will be found the notes on distribution, food habits, etc. The range and distribution in Iowa have been determined in part from Professor Herbert Osborn's brief notes but largely from specimens collected in many localities in the state by the writer and others.

The system of classification followed herein is, for the most part, that of Reuter and is adopted by Van Duzee for the Heteroptera in his "Check List of the Hemiptera of America North of Mexico," as well as in his "Catalogue of the Hemiptera of America North of Mexico." A few minor changes have been made from these works but the sequence of families and genera

conforms to Van Duzee's Check List and the system of nomenclature employed by him has been followed in the main.

The principal works consulted in the preparation of this paper are included in the Bibliography which contains not only references to Iowa species but to other forms as well.

In order to secure data and material for comparison and study, collecting has been done and observation made in different parts of the state for several summers past. In this way a great mass of material has been obtained. Since little more than lists of the Iowa species of this group have heretofore appeared, it is hoped that the information contained in this paper concerning the Iowa forms of this interesting group may be brought down to date and, perhaps, give an impetus to future work on Iowa Hemiptera.

In presenting this paper the writer desires to gratefully acknowledge his deep sense of obligation to Professor H. F. Wickham for continued assistance, suggestions and helpful criticism as well as for many specimens and valuable literature.

Dr. G. F. Kay, Director of the Iowa Geological Survey, has made possible the securing of much material by granting the writer the privilege of collecting insects in many parts of the state while undertaking another line of work expressly for the Survey.

Miss Jane E. Roberts, University Librarian, has aided in securing books and papers essential in the preparation of this work.

Messrs. E. P. Van Duzee, H. G. Barber, H. M. Parshley, J. R. de la Torre Bueno, C. E. Olsen and W. L. McAtee all have been of assistance with helpful correspondence and specimens.

To Professor B. Shimek, Head of the Department of Botany at the State University, the writer is indebted for the determination of most of the plants cited in these pages.

In addition to those above mentioned, the following have furnished specimens for study and comparison: N. K. Bigelow, L. L. Buchanan, H. E. Ewing, J. L. Horsfall, O. W. Rosewall, R. L. Webster and A. W. Lindsey.

Mrs. Stoner who has accompanied the writer on numerous collecting trips has taken many specimens and has continually given encouragement and aid.

SYSTEMATIC DISCUSSION

Order HEMIPTERA Linnaeus

The Hemiptera as indicated in the time of Linnaeus were, in substance, those of the present day except that the Thrips are now excluded. The name Rhynchota or Rhyngota has been used from time to time by various authors to designate this order but this seems to have come about through Fabricius' use of the name in his "Systema Entomologiae" published in 1775. However, in order to be consistent with the laws of priority we must adhere to the nomenclature offered by Linnaeus in the 10th edition of his "Systema Naturae" published in 1758.

This order contains about 35,000 described species, approximately 7,000 of which are found in North America. Great variety in form, color, structure and habits obtains in the order which is also of considerable economic importance. This fact is forcefully put by David Sharp, the noted English entomologist who says that "If anything were to exterminate the enemies of Hemiptera, we ourselves should probably be starved in the course of a few months."

Apparently the Hemiptera are not very closely related to any other order of existing insects. The earliest hemipteroid type apparently dates from the Lower Permian in the species *Eugercon boeckingi* Dohrn, and it is in this form that we find the first instance of typical hemipterous mouth parts. Although the record is far from complete, this ancient Protohemipteron probably connects up the Palaeodictyoptera with the modern Hemiptera.

The members of the order Hemiptera are contained in two fairly easily delimitable suborders, the Homoptera and the Heteroptera which, early in the geological history of the group, became differentiated from each other. It is with the Heteroptera only that we have to deal here.

Suborder HETEROPTERA Latreille

About two-thirds of the total number of Hemiptera are Heteroptera and in North America in the neighborhood of 1500 species have been described.

Series **POLYNEURIA** Reuter

In the classification adopted by Reuter, seven series are recognized as making up the Heteroptera. By thus breaking up that suborder, the affinities of the families are made more apparent since it is evident that all the forms contained in the old series Gymnocerata, of which the Scutelleroidea formed a part, were not genetically related. The series Polyneuria in which the superfamily Scutelleroidea is now placed may be diagnosed briefly as follows:

Head never transversely impressed before the eyes; antennae longer, usually much longer than the head; beak usually of four segments, rarely with three, in which case the last two segments are confluent. Pectus never composite. Meso- and metasterna simple. Hemelytra provided with a clavus corium and membrane; membrane with many veins, seldom with few veins. Ventral abdominal stigmata two to seven. Coxae rotatory. Tarsal claws provided with arolia. Eggs operculate; micropyles not parietal; embryo provided with an apparatus on the occipital portion of the head for breaking the operculum of the egg.

Superfamily SCUTELLEROIDEA (Burmeister)

Head very often distinctly clypeate or shield-shaped; ocelli usually present; antennae usually of five segments, rarely of three, four, or more than five; antenniferous tubercles within the lateral margins of the head; antenniferous spine seldom developed on head. Scutellum large or very large, usually at least reaching middle of abdomen, the apex often covering the interior basal angle of the membrane, sometimes covering the entire dorsal surface of the abdomen. Clavus in the macropterous forms attenuate at apex forming no commissure or a very short one (Urolabidae) internally behind the apex of the scutellum; membrane usually with numerous veins, sometimes anastomosing, rarely with few veins, in which case the scutellum is large.

This group of the Heteroptera consists, for the most part, of large and fine appearing species which are quite easily seen and as easily captured. The members of the superfamily are practically cosmopolitan in distribution but are more characteristic

of tropical and subtropical regions. It is the largest group of the Heteroptera and approximately 6,000 recent species have been described while about 150 fossil forms have been discovered. Most of the latter are from the Tertiaries of Europe and America. But 235 modern species are recorded from America north of Mexico by Van Duzee¹; they are distributed in the three families as follows:

Scutelleridae—14 genera—26 species

Cydnidae—10 genera—45 species

Pentatomidae—54 genera—164 species

- Of Iowa forms, the total recorded number for the state is, with this paper, brought to 65 species and subspecies distributed in the three families as follows:

Scutelleridae—2 genera—4 species

Cydnidae—6 genera—12 species

Pentatomidae—25 genera—47 species and subspecies.

Comparatively few of the American genera are represented in Europe and the center of dispersal in both Palaearctic and Nearctic regions seems to have been in the south. The genus *Nezara* enjoys an exceptionally wide distribution being universally distributed in Nearctic, Neotropical, Palaearctic, Ethiopian, Oriental and Australian regions.

The pentatomid records at hand seem to show that the encroachment of heretofore unrecorded forms is from the west and southwest and that the wave of dispersal is towards the north and northeast. In substantiation of this statement the following recent additions to our fauna may be mentioned; *Cydnus obliquus* Uhler, *Prionosoma podopioides* Uhler, *Murgantia histrionica* Hahn and *Euschistus tristigmus* var. *pyrrhocerus* H. S.

The state of Iowa is situated near the center of the United States lying between 40° 20' and 43° 30' north latitude and between 90° 15' and 96° 43' west longitude. The greatest length from east to west is about 328 miles and the greatest width from north to south is about 215 miles. The area is roughly 55,480 square miles most of which is a more or less "monotonous

¹Van Duzee, E. P., Check List of the Hemiptera of America North of Mexico, N. Y. Ent. Soc., 1916.

plain'' now very largely under a high state of cultivation. This plain lies between the Missouri and Mississippi rivers above which it rises very little, the lowest point in the state, in southeastern Iowa, having an elevation of about 480 feet and the highest point, in northwestern Iowa, having an elevation of about 1700 feet. A somewhat ill-defined watershed extends from Dickinson county in the northwest to Wayne county in the south central part of the state. Approximately two-thirds of the total area lies east of this sinuous ridge and less than one-third west of it.

The so-called Driftless area which has not been covered by an ice sheet occupies only a small area of northeastern Iowa. Here, deep valleys, high rocky cliffs, steep hills and thin soils are the rule. The Drift-covered area which has been covered by well defined ice sheets occupies by far the larger portion of the state.

The Kansan drift which covers most of southern, south central, and western Iowa presents steep ravines and rounded hills and the entire area is well drained. In southeastern Iowa the Illinoian drift presents a more level and rolling surface. In northeastern Iowa, just to the west of the Driftless area the Iowa drift sheet is present and is characterized by the small amount of erosion, small streams and, in early days, by many undrained sloughs. The Wisconsin drift sheet extends in a more or less triangular lobe over most of northwestern Iowa and south as far as central Iowa. Little erosion has taken place and drainage is not good so that great numbers of lakes, marshes and sloughs are formed. Along the edges of this drift sheet are numerous small gravelly hills and mounds.

According to the divisions made by Dr. C. H. Merriam², the greater part of Iowa lies in the Upper Austral Zone (Carolinian) with the Transition Zone (Alleghanian) represented only by a short lobe in the northern part of the state. This lobe extends from the western third of the state line east nearly to the Mississippi river and is not more than two or three counties deep at its widest part.

Cold winters and hot summers, the latter probably attracting some of the southern species of insects, are the rule in Iowa. In-

²Merriam, C. H., Life Zones and Crop Zones of the United States, Bull. No. 10, U. S. Dept. Agr. Bur. Biol. Surv., 1898.

deed, the winters are colder and the summers hotter than for the same parallels near the eastern coast of the United States. Sudden and marked changes in temperature are not uncommon and these probably serve as an effective barrier to the northward dispersal of many of the less hardy southern forms. Then too, Iowa is just on the border line between fairly typical eastern and western conditions as well as between Transition and Lower Austral so that the fauna is likely to be somewhat varied in its affinities. In the western part of the state in particular, conditions begin to assume those of the Great Plains region and here one is at once struck with the intermediate character of the pentatomid as well as other faunas.

The appended table will serve to show in graphic form something of the relation of the pentatomid faunas of Florida, New England and Nebraska to the fauna of Iowa. The basis of these records is taken from the published lists together with specimens received from the localities mentioned. In preparing the data for tabulation the nomenclature has been made to conform to the system employed in this paper in order that a uniform basis for comparison may be obtained.

	Genera in list	Genera com- mon to Iowa	Species and sub- species in list	Species and sub- species common to Iowa
Iowa	33	..	63	..
Florida	44	23	80	30
New England	36	31	59	46
Nebraska	35	30	68	50

Until recently little has been done on the group Scutelleroidea in Iowa outside the lists and a few notes by Professor Herbert Osborn. During the past four or five years the writer has been collecting material and issuing brief progress reports in the way of distributional and ecological notes from time to time.

All of Osborn's notes on Iowa pentatomids were published in the Proceedings of the Iowa Academy of Sciences and the dates, together with brief summaries of his papers are herewith appended in chronological order so that the historical setting of this work may be brought to mind.

Proc. Ia. Acad. Sci. for 1888, Vol. I, 1890, page 49, Herbert Osborn, "The Hemipterous Fauna of Iowa" (Abstract). In

this paper the number of families of Homoptera and Heteroptera occurring in the state is mentioned as well as the number of genera and species in each family. Twenty-one families are listed for the Heteroptera. Of the Scutelleroidea, the number of genera and species in each family is indicated as follows:

Scutelleridae	2 genera	2 species
Thyreocoridae	1 genus	3 species
Cydnidae	2 genera	2 species
Pentatomidae	17 genera	26 species
Total	22 genera	33 species

Proc. Ia. Acad. Sci., Vol. I, Part II, 1892, pages 120-131, Herbert Osborn, "Catalogue of the Hemiptera of Iowa." In this paper the number of the Scutelleroidea recorded from the state is raised to thirty-seven. They are distributed among the families as follows:

Scutelleridae	2 species
Thyreocoridae	3 species
Cydnidae	3 species
Pentatomidae	29 species

Localities and abundance only are given.

Proc. Ia. Acad. Sci., Vol. I, Part IV, 1894, pages 120-123, Herbert Osborn, "Notes on the Distribution of Hemiptera." At this time an additional species (*Eurygaster alternatus* Say) was recorded for Iowa, thus raising the number of recorded Iowa species of pentatomids to thirty-eight. Little more than locality records for this species and for other species before recorded are given. Twenty-nine species of pentatomids are mentioned in the paper but most are listed from other states.

Proc. Ia. Acad. Sci., Vol. IV, 1897, pages 172-234, Herbert Osborn and E. D. Ball, "Contributions to the Hemipterous Fauna of Iowa." Here, locality records for a few species of pentatomids are given.

Proc. Ia. Acad. Sci., Vol. V, 1898, pages 232-247, Herbert Osborn, "Additions to the List of Hemiptera of Iowa with Descriptions of New Species." In this paper eight additional species are listed along with one genus, *Geotomus* sp. of the family Cydnidae.

Proc. Ia. Acad. Sci., Vol. VI, 1899, pages 36-39, Herbert

Osborn, "Notes on Hemiptera of Northwestern Iowa." Four additional species are listed at this time so that the total number of recorded species to this date was fifty-one. Brief notes on the abundance, occurrence, etc., of the four newly recorded species are given along with some similar data on other species of Hemiptera.

Summing up, then, all the species of Scutelleroidea recorded by Osborn we find a total of fifty-one. His first list, which was also the first list for the state, gave a total of thirty-three species so that during the decade from 1888, the year of the appearance of the first list, to 1898, the year in which the last additions were made to this list, an increase of eighteen species is noted.

Another paper entitled, "A Generic Synopsis of the Nearctic Pentatomidae," although not dealing particularly with the Iowa fauna, was published by Professor H. E. Summers in the Proceedings of the Iowa Academy of Science, Volume VI, 1899, pages 40-46. This work is largely a translation and rearrangement of the Nearctic genera and subfamilies as found in Stål's "Enumeratio Hemipterorum" and affords a convenient table for determining the Iowa genera.

Most persons are familiar with the members of this group as a whole from the fact that when one of the bugs is disturbed an exceedingly ill-smelling odor is given off and this coupled with the propensity of several species for crawling on berry vines of different sorts is accountable for the appellation they have received of "stink bugs" or "berry bugs." The odor emanates from an internal secretion which may be liberated at the will of the insect and which is possessed in varying degrees by other Heteroptera as well. In the nymph the odoriferous orifices are found on the dorsal side of the abdomen which is largely exposed since the wings and scutellum are comparatively little developed, thus permitting the glands to exercise their protective function to the best advantage. In the adult, however, the fluid issues from a small opening in the episternum at either side of the mid-coxae. The shape and disposition of this orifice, the ostiolar opening, is of some taxonomic importance.

Many of the species of Scutelleroidea are of considerable economic importance from the standpoint of agriculture. Some

are beneficial, others are harmful although in our own state damage of a serious nature has not yet been reported.

Most of these bugs are mainly or wholly plant feeders and during both the adult and nymphal stages feed by inserting their beaks into the plant tissues and extracting the juices therefrom. Important vegetable and truck crops are often subject to injury. Growing shoots of plants and developed fruit are usually chosen for points of attack and they may be retarded in growth or killed if the infestation be severe. In addition to this damage from the punctures themselves, recent investigations have shown that some of the pentatomids at least are distributors of certain fungous diseases in plants. In the Southern States the Harlequin Cabbage Bug, *Murgantia histrionica* (Hahn), and the Southern Green Plant Bug, *Nezara viridula* Linn., are two of the most serious pests with which the truck farmer and fruit grower have to contend.

The genus *Euschistus* which contains one of our most widely distributed and abundant species, *E. variolarius* (P. B.), includes other species which are mainly plant feeders, although a few are more or less predaceous and destroy noxious insects. *Euschistus variolarius* is known to feed on *Carduus*, *Thermopsis*, maize, asparagus, broom corn, oats, rye, red clover, tomatoes, raspberry, mullein, tobacco, grasses and peaches. It is also said to feed on some lepidopterous larvæ. Of course it is only when the number of such insects increases greatly above normal that marked damage is done.

The members of the subfamily Asopinae may be, on the whole, classed among our beneficial bugs for they feed, in part at least, on noxious insects. In the nymphal stages many of these bugs are plant feeders while in the adult stage some are predaceous and others are both predaceous and plant feeders. Members of the genera *Apateticus* and *Podisus* are included here and among the insects attacked by the Iowa representatives may be mentioned several species of leaf beetles of the family Chrysomelidae.

The negro bugs of the genus *Thyreocoris* often attack cultivated plants and although no serious outbreak has occurred in Iowa, some damage has been noted on potatoes, wheat, tomatoes and other garden truck. In the South, tobacco is often injured

by these bugs. More detailed and specific data on feeding habits and foot plants of various Iowa pentatomids are included in the discussions farther on in this paper.

Most of the pentatomids are taken by beating vegetation of different sorts with a sweep net. Cultivated or semi-cultivated areas offer better collecting grounds than do wild, uncultivated areas. Roadsides, fence rows, margins of grain and hay fields, the edges of woods—these are most productive of specimens. The cydnids are usually found in more or less sandy places in or near the ground on low vegetation. Thyreocorids are found usually on small cultivated or semi-cultivated plants and often in more or less moist situations. The scutellerids are more typical of open prairie country and are found in greatest abundance in the western portion of the state. Some of the Scutelleroidea hibernate under sticks, leaves, grasses, rocks, etc. during the winter months and a few forms have been found in practically every month of the year.

When any difference in size between the sexes prevails—a common occurrence—the female is usually the larger. However, considerable variation in size is met with among individuals of both sexes of a given species though usually within fairly definite limits.

Phalanx PENTATOMIFORMES Reuter

Only the present group of the three into which the Scutelleroidea is divided is found in North America. The principal diagnostic characters of this division are as follows:

Body below convex or flattened. Rostrum inserted beneath or near apex of clypeus, seldom on basal half of gula, in which case the veins of the membrane begin near the interior basal angle. Mesostethus reaching sides of body, truncate externally and completely separating the pro- and metastethus. Sides of prothorax retrorse, not produced; meso- and metanota concealed. Hemelytra not folding; corium entirely coriaceous, reaching side of body near base and appearing as an epipleuron; not surpassing apex of abdomen and not prolonged beside the outer margin of the membrane; veins of membrane supple, often reticulate, never pectino-radiate. Connexivum horizontal or slightly declivous. Tarsi of three segments, rarely of two segments, in which event the scutellum is much narrower than the abdomen.

Key to the families of Pentatomiformes

- Connexivum of abdomen with six visible dorsal segments; first ventral abdominal segment entirely or almost entirely concealed by the metasternum, visible only at middle. Tibiae set with rows of heavy spines.....CYDNIDAE (2)
- Connexivum of abdomen with seven visible dorsal segments; second (apparently the first) ventral abdominal segment visible for its entire width. Tibiae not strongly spinose but often thickly haired.
- Scutellum covering almost entire abdomen and usually convex; colors dullSCUTELLERIDAE (1)
- Scutellum usually moderate in size, more or less narrowed at apex. If scutellum is large, colors are bright and contrasty or the pronotum bears a prominent tooth anterior to the lateral anglesPENTATOMIDAE (3)

Family SCUTELLERIDAE (Leach)

This family is more characteristic of the Palaearctic, Ethiopian, Oriental and Australian regions; less than one-half the total number of described species are from Nearctic and Neotropical regions.

The species of the family exhibit great variation in color and size, on this account giving considerable difficulty in their determination which has resulted, in some cases, in extended synonymy.

Four species placed in two genera are recorded for Iowa. In the United States the members of the family are more abundant to the west and southwest. The principal diagnostic characters may be briefly summarized as follows:

Scutellum entirely or almost entirely covering the abdomen. Veins of membrane arising from a vein at exterior basal angle running transversely, arcuately inwards, gradually retreating from the interior basal angle; corium broad, obtuse at apex. Primary and subtended veins of wing remote, enclosing a rather wide area, not regularly converging towards apex; hamus present. Frenum absent. Basal ventral abdominal segment distinct at the sides; connexivum of abdomen with seven dorsal segments; six segments only are distinct from below. Tibiae not strongly spinose.

Key to the subfamilies

Venter with elongate, finely and densely striate stridulating

spot on each side of disc; orifices very distinct....TETRYINAE
 Venter without stridulating spot; orifices prolonged into a
 groove ODONTOTARSINAE

Subfamily TETRYINAE (Stål)

Most of the members of this subfamily are confined to the Nearctic and Neotropical regions. Two genera have representatives in the Ethiopian and Oriental regions only. About twenty species which are included in nine genera occur in North America. Three species, all in the same genus, have been recorded from Iowa. The principal differential characters are:

Body generally convex below, more or less pubescent. Pronotum and scutellum forming a continuous curve at base (in the North American forms); posterior angles of pronotum obtuse, rounded. Meso- and metasterna not bordered by a carina. Orifices very distinct. Ventral incisures transverse, straight or bisinuate, at the sides curved rather abruptly before rejoining border of venter. An oblong, finely striated stridulating spot in both sexes on either side of the disc of at least the fourth and fifth visible ventral segments.

Genus HOMAEMUS Dallas

1851. HOMAEMUS Dallas, List Hem., I, 36.

Body ovate, somewhat convex. Head longer than broad but shorter than pronotum, rounded in front, lateral margins nearly straight, somewhat sinuate in front of eyes. Rostrum attaining second visible ventral abdominal segment and with the second segment as long as the third and fourth together, the fourth segment a little shorter than the third. Antennae of five segments, the first and second subequal, second segment shorter than third, fourth and fifth segments about equal and longer than the third. Anterior margin of prostethus forming flaps covering the bases of antennae. Orifices prolonged into a groove. Scutellum attaining apex of abdomen. Venter with sides convex, the borders depressed. Tibiae grooved on superior surface.

Key to the species

Dilated anterior margin of prostethus rounded, not forming an obtuse angle beneath antennal tubercles

Anterior prolongation of sixth visible ventral segment broad, distinctly angled; head generally bronze-black, devoid of pale submarginal vittae and without pubescence; sexes similar; length, 7.0-9.5 mm. *aeneifrons*

Anterior prolongation of sixth visible ventral segment rounded; head generally with pale submarginal vittae and

with whitish decumbent pubescence; sexes rather unlike;
length, 6.0-8.0 mm.....*bijugis*

Dilated anterior margin of prostethus forming a distinct obtuse
angle beneath antennal tubercles*proteus*

Homaemus aeneifrons (Say)

- 1824. *Scutellera aeneifrons* Say, Long's Exped. Source St. Peter's R., II, 299.
- 1839. *Pachycoris exilis* H.-S., Wanz. Ins., IV, 5, fig. 346.
- 1839. *Pachycoris exilis* Germar, Zeitschr. Ent., I, 98.
- 1851. *Homaemus exilis* Dallas, List Hem., I, 36, Pl. I, fig. 5.
- 1859. *Scutellera aeneifrons* Say, Compl. Writ., I, 199.
- 1870. *Homaemus aeneifrons* Stål, Svensk. Vet. Handl., 9, no. 1, 15.
- 1877. *Homaemus aeneifrons* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 365.
- 1880. *Homaemus aeneifrons* Distant, B. C. A., Rhynch. Het., I, 20.
- 1904. *Homaemus aeneifrons* Schout., Gen. Ins., fasc. 24, 59.
- 1904. *Homaemus aeneifrons* Van D., Trans. Am. Ent. Soc., XXX, 13 and 76.

Body ovate, narrowed posteriorly and varying in color from dull to pale yellowish variegated with fuscous or black. Head convex, densely, coarsely punctured and without pubescence; black or bronzed with cupreous reflections; a deeply impressed line each side of the tylus which latter slightly surpasses the juga; juga sometimes margined near tip with a short, very narrow pale vitta. Antennae fuscous, the incisures paler; basal segment pale clay yellow. Thorax dull or pale yellowish with faint and not sharply defined longitudinal fuscous lines; more finely and not so closely punctured as head; a smooth, pale transverse spot enclosed by a row of fine punctures near anterior margin either side of the middle; margins pale, almost straight, somewhat explanate; humeri rounded, entire; a closely punctured, irregular bronzed area either side of pectus. Scutellum dull or pale yellowish variegated with fuscous or black similar to pronotum; more deeply and coarsely punctured at base, the punctuations becoming finer and closer towards apex; a little longer but a little narrower than abdomen thus exposing three or four segments of the maculated connexivum. Embolium more coarsely punctate than corium. Abdomen beneath pale with irregularly disposed coarse black punctures. Sixth visible ventral segment with a broad, somewhat angulate anterior prolongation. Femora and tibiae pale yellow, heavily and irregularly dotted with black; tarsi and claws fuscous or black. Length, 7.0-9.5 mm. Width across pronotum, 4.0-5.5 mm.

This species is rather close to the one following but the characters indicated should serve very well in separating the two forms. It is widely distributed although it appears to be much less common in the state than *H. bijugis*. But five specimens have been taken at Lake Okoboji, Estherville, Rock Rapids and Ames, all toward the western and northwestern part of Iowa. A single specimen from Dallas county is in the collection of the United States National Museum. Osborn recorded the species as

rare in 1897, three specimens having been taken at Ames. It is most likely to be taken in prairie pastures.

Homaemus bijugis Uhler (PLATE IV, FIGURE 2)

1872. *Homaemus bijugis* Uhler, Rept. U. S. Geol. Surv., V, 398.

1876. *Homaemus consors* Uhler, Bull. U. S. Geol. Geogr. Surv., II, No. 5, 272.

1904. *Homaemus bijugis* Schout., Gen. Ins., fasc. 24, 60, Pl. 5, fig. 1.

1904. *Homaemus bijugis* Van D., Trans. Am. Ent. Soc., XXX, 13 and 76.

Body elongate oval, pale yellowish to testaceous, variegated with fuscous or black. Head long, bronzed, distinctly narrowing toward tip; marginal and submarginal lines yellow, the surface densely, rather finely punctured and with remote whitish pubescence; tylus yellowish at tip and slightly longer than lateral lobes. Rostrum reaching to middle of second visible ventral segment, dull yellowish, the apex piceous. Antennae fuscous, the incisures paler; basal segment pale clay yellow. Pronotum regularly convex, the lateral margins straight, edges smooth, compressed; surface remotely punctate with fuscous and pale brown, the fuscous punctures forming two oblique longitudinal rows either side of the median line; sometimes another and fainter ray extends forward from the humerus; callosities surrounded by a group of fine black punctures; posterior angles moderately rounded, the anterior angles less noticeably rounded. Scutellum elongate, narrowing gradually to tip, punctured rather finely but irregularly with pale brown to black. A series of blackish punctures at base either side of the middle curves outward to beyond the middle; median line pale clay yellow, expanded for almost the posterior one-half where the margins are sharply defined by black punctures. Venter pale clay yellow, the punctures smaller, paler and more remote than in *H. aeneifrons*; edge of abdomen beneath with obsolete or entirely without black spots; connexivum above black within, the outer margin immaculate, pale clay yellow. Sixth visible ventral segment with anterior prolongation narrow, somewhat rounded. Legs pale yellow. The number of fuscous dots on the femora averages less than in *H. aeneifrons*; last tarsal segment and claws piceous. Length, 6.0-8.0 mm. Width across pronotum, 4.0-5.0 mm.

In this species the difference in size, as well as, in some cases, the color between the two sexes is very marked. The male is much smaller than the female, with a more pointed scutellum which is reticulated above to a greater or lesser degree with black. The smooth median line with its expanded apex is less plainly indicated while the yellow submarginal line is slender, more obscure, sometimes obsolete before the base. Even the females are subject to a good deal of variation in size, general coloration, density of punctuation and the distinctness of the yellow submarginal line of the head.

In addition to the differential characters already pointed out between this and the preceding species, may be mentioned the finer punctuation of the head and its more greenish, iridescent reflections which obtain in *H. bijugis*.

This species is more generally distributed over the state than the preceding and in the western and northwestern parts is even very abundant at certain seasons. Most of our specimens have been taken from prairie and blue grass pastures along the edges of woods. At Waukon, specimens were taken in a field of timothy and clover. In the summer of 1916, of the one hundred and fifty-five specimens collected in the Okoboji region, twenty-two were nymphs most of which were taken in June, although few half grown ones were taken as late as August 16. Adults increased in numbers as the season advanced until the maximum of abundance was attained in August.

In addition to the localities above mentioned, specimens are at hand from Estherville, Granite, Iowa City, Monticello, Rock Rapids, Sibley, Silver Lake and Storm Lake.

Homaemus proteus Stål (PLATE IV, FIGURE 3)

1862. *Homaemus proteus* Stål, Stett. Ent. Zeit., XXIII, 82.

1880. *Homaemus proteus* Distant, B. C. A. Rhynch. Het., I, 20, Pl. 2, figs. 3 and 4.

1904. *Homaemus proteus* Uhler, Proc. U. S. Nat. Mus., XXVII, 349.

1904. *Homaemus proteus* Van Duzee, Trans. Am. Ent. Soc., XXX, 15.

1904. *Homaemus proteus* Schouteden, Gen. Ins., fasc. 24, 60.

Body ovate, wider behind middle, yellowish, rather densely and deeply punctured with fuscous or blackish. Head short, bronzed, broad and convex toward apex, the surface densely, finely punctured and with rather dense whitish pubescence; a pale line, sometimes indistinct, down middle of tylus which is also yellowish at tip; a broader pale line on each cheek separated from median vitta by the narrow, black, impressed margins of tylus; lateral edges of head with a very faint pale line. Rostrum dull yellowish, the two apical segments fuscous. Antennae varying from dark yellow to fuscous; incisures and basal segment pale clay yellow. Pronotum more convex than in *H. aeneifrons* or *H. bijugis*, particularly towards the lateral margins which are almost straight, the edges narrowly reflexed; surface rather closely punctured with fuscous, the punctures forming two, sometimes three, more or less distinct oblique rows either side of the smooth median line; anterior one-third and antero-lateral margins of pronotum with short, remote whitish pubescence; humeral angles not prominent; callosities surrounded by a row of fine black punctures and by whitish pubescence. Scutellum more convex and narrower at tip than in *H. aeneifrons* or *H. bijugis*, widest behind middle; punctured

finely, irregularly with fuscous; median line pale clay yellow and in the female expanded for about the posterior one-half, the margins not sharply defined towards tip; a series of blackish punctures either side of median line at base forms two short lines whose apices curve toward each other; a large irregular brownish or black area made up of closely set punctures either side of median line a little in front of middle. Hemelytra with a large angulate fuscous or black area interior to apex of coriaceous portion. Venter dull yellow, irregularly and deeply punctured with black; stridulating spots very distinct; connexivum marked with black points at the incisures. Legs conspicuously covered with short yellowish or whitish hairs heavier and more closely implanted on the tibiae; coxae pale yellow, the femora and tibiae deeply and in some places confluent punctured with fuscous; apical tarsal segment darker than the others; claws tipped with black. Length, 6.0-7.5 mm. Width across pronotum 4.0-4.75 mm.

This species is subject to about the same degree of variation as the other representatives of the genus. In the specimens before me the posterior half of the lateral margin of each segment is not distinctly darker than the remainder of the segment. The markings of the prothorax and scutellum have been used as a basis for division into varieties.

Osborn recorded this southern species from Iowa in 1890 but, as Van Duzee suggests, "It is just possible that this reference is an error either of determination or locality" (*l. c.*). Specimens have not been taken in Iowa by us and the recorded range in the United States is far to the southwest.

Subfamily ODONTOTARSINAE (Stål)

This subfamily is but poorly represented in North America, a total of but five genera and ten forms being recorded. Over 75 percent of the described forms are from the Palaearctic region. A single species is recorded for Iowa.

Body about equally convex above and below, not pubescent. Second segment of antennae straight or slightly curved at base. Pronotum and scutellum continuous at base; basal angles of pronotum obtusely rounded; antero-lateral border of pronotum generally little or not at all arcuated. Meso- and metasternal groove plain, sometimes limited at each side by a crest or tubercle but never by a carina. Orifices distinct or not. Ventral incisures more or less gradually curved on disk. No striate stridulating spot.

Genus EURYGASTER Laporte de Castelnau

1832. EURYGASTER Laporte de Castelnau, *Essai Classif. Syst. Hémip.*, 68 and 69.

Body oval or widely ovoid, subdepressed. Head equal to or a little shorter than pronotum, triangular, not or indistinctly sinuate in front of eyes, flattened above, wider than long. Rostrum reaching almost to posterior coxae; second segment at least equal in length to third and fourth together. Antennae of five segments, the first not extending beyond anterior margin of head, the second curved, the first three segments of practically the same length or the second segment a little longer than the first or third. Pronotum almost twice as wide as long, hexagonal. Prostethus slightly dilated in front, becoming smaller and rounded towards rostrum. Orifices prolonged into a groove. Scutellum as long as but somewhat narrower than abdomen, the margins subparallel or slightly diverging from the base. Venter not grooved but the base with a slight median longitudinal depression; sides flattened, the borders straight. Tibiae grooved more or less distinctly on superior face.

Eurygaster alternatus (Say) (PLATE I, FIGURE 1, and PLATE II, FIGURE 1)

- 1828. *Tetyra alternata* Say, Amer. Ent., 111, Pl. 43, lower left fig.
- 1851. *Eurygaster alternatus* Dallas, List Hem., I, 47.
- 1859. *Tetyra alternata* Say, Compl. Writ., I, 94, Pl. 43, fig. 3.
- 1872. *Eurygaster nicoletanensis* Prov., Nat. Can., IV, 73.
- 1877. *Eurygaster alternatus* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 365.
- 1904. *Eurygaster alternatus* Van D., Trans. Am. Ent. Soc., XXX, 18.
- 1909. *Eurygaster alternatus* Kirkaldy, Cat. Hem. (Heterop.), I, 273.

Body elongate oval, depressed, triangular before, widest behind middle and broad at posterior end. Color varying from rufous to yellow, closely, irregularly and rather finely punctate. Head short, convex, somewhat narrowed anteriorly, rounded at tip; tylus attaining apex of head and bordered on either side by a black line which is continued to posterior border of head; margin of head paler; beneath with a black line from eyes to apex of cheeks. Rostrum pale yellow, the two apical segments fuscous. Antennae fuscous, basal segment pale yellow, apical segment longest and blackish. Pronotum only slightly convex, rather uniformly and densely punctured; posterior angles obtusely rounded, the posterolateral edge almost straight; antero-lateral margins nearly straight; on either side of the more or less distinct smooth median longitudinal line is a darker longitudinal line, sometimes faint, sometimes well marked, which diverges from the median line as it proceeds backward; callosities transverse, usually faintly marked. Scutellum rufous to yellow, narrower and longer than abdomen, the edges almost straight; a slightly curved, smooth, raised line at base and from this a slightly carinate longitudinal line extends backward and disappears on the posterior half which is depressed; median line pale yellow and expanded posteriorly; the entire scutellum more or less marked with short, transverse or semitransverse black lines composed of series of punctures. Coriaceous portion of hemelytra similarly marked. Connexivum with a series of black punctures forming a quadrate spot at the middle of each segment. Pleurae more

coarsely punctate than scutellum; an elongate smooth line on pro- and mesopleurae. Ostiolar canal fuscous at tip but not expanded. Venter rufous to yellow, finely, sparsely punctate at sides, more coarsely punctate at middle; two more or less distinct black lines gradually approach each other posteriorly to unite in a single spot on the last segment. Genital segment of male broadly but not deeply sinuate. Legs heavily dotted with fuscous; last tarsal segment and tips of claws piceous. Length, 6.5-10.0 mm. Width across pronotum, 4.5-6.0 mm.

This scutellerid exhibits much variation, as do some other members of the family, in both size and color. In length it varies from 6.5 to 10.0 mm. and in color from light olive-gray to dark brown; the maculations on the connexivum are sometimes indistinct or wanting. All my Iowa specimens are dark in color and the alterations on the connexivum are distinct.

Although this form is widely distributed in North America we have not found it east of the center of the state and have taken it only at Red Oak, Sibley, Lake Okoboji and Emmetsburg. Two nymphs were taken at Lake Okoboji in July. Professor Osborn recorded this species as "not common" but cited no localities. The few specimens collected by us have all been taken on comparatively low land. The Okoboji specimens were swept from timothy and blue grass growing on low swampy prairie and along roadsides.

Family CYDNIDAE (Billberg)

This family, as now understood, contains two compact though quite readily separable and distinct subfamilies which have, until recently, usually been accorded family rank. Although the two groups differ much from each other in general appearance, a study of the detailed structural characters indicates close relationship. In distribution the family is mainly Nearctic and Neotropical. About fifty representatives are found in North America. The majority of these are more particularly characteristic of the desert and semiarid conditions of the West and Southwest. Twelve forms are, with this paper, now recorded from Iowa. The principal differential characters of the family follow:

Scutellum moderate and flattened or covering almost entire abdomen and very convex; in the latter case the wings are without a hamus. Veins of membrane arising near interior basal angle or from this angle by a

vein running parallel to margin of corium. Corium more or less narrowed. Basal segment of venter very narrow, entirely or almost entirely covered by metasternum. Connexivum of abdomen with six visible dorsal segments. Tibiae more or less strongly spinose, the spines arranged in rows. Tarsi 3-segmented.

Key to subfamilies

Scutellum broad, convex, covering most of the abdomen and longer than the corium; apex of corium narrowed **THYREOCORINAE**
 Scutellum triangular, narrowed at tip, more or less flattened and shorter than corium; apex of corium broader. **CYDNINAE**

Subfamily **THYREOCORINAE** (Van Duzee)

The insects, sometimes called "negro bugs," which comprise this subfamily although apparently superficially quite unlike the members of the subfamily Cydninae, do have important structural modifications which entitle them to be placed in the same family. But one genus containing seventeen species is recorded from North America. Four of the species are widely distributed over the United States but the others are more particularly characteristic of the West and Southwest. Five species have been taken in Iowa. All but one of the North American species are black. In all, the scutellum is rather deeply convex and entirely or almost entirely covers the abdomen.

Our forms are usually found on vegetation growing in damp places although *Thyreocoris nitiduloides* is often present on the dry prairies. The short grasses and weeds about the edges of woods and cultivated fields frequently yield numbers of these bugs. *Thyreocoris pulicarius* sometimes attacks cultivated plants and under favorable conditions its numbers may so increase that the species becomes a real pest. The principal characters of the subfamily are as follows:

Body oval, convex. General color usually deep black or bronzed black. Head more or less triangular. Antennae of five segments. Scutellum very convex, longer than corium, broadly rounded and entirely or almost entirely covering abdomen. Apex of corium narrowed. Non-fossorial. Tibiae furnished with spines, usually slender; few long hairs.

Genus **THYREOCORIS** Schrank

1801. **THYREOCORIS** Schrank, Fauna Boica, II, 46.

General form more or less ovate, very convex. Head large, anterior border straight or slightly sinuate. Antennae longer than head, the sec-

ond segment much shorter than the others. Rostrum not extending on to abdomen, the second segment longest. Pronotum transverse, the lateral borders rounded, the posterior border slightly sinuate at middle. Scutellum large, deeply convex, not covering outer part of corium but usually entirely covering the membrane and abdomen. Tibiae furnished with spines.

Key to the species

Hemelytra concolorous, not marked with paler

Surface highly polished; punctures almost obsolete on dorsal surface; corium without a prominent ridge parallel to subcostal nervure; form regularly oval; length, 5.0-6.0 mm. *ater*

Surface distinctly punctured; corium with a prominent ridge within and parallel to subcostal nervure; length 4.0-4.5 mm.

Form more or less narrowed posteriorly; somewhat polished; distinctly but not closely punctured; base of pronotum not or scarcely transversely wrinkled *nitiduloides*

Form short, oval; somewhat opaque and closely punctured; base of scutellum and pronotum transversely wrinkled

..... *niger*

Hemelytra marked with white or yellow

Pale margin of corium narrowed at base and not crossing subcostal nervure; length, 3.5-4.0 mm. *lateralis*

Pale margin of corium broad at base, crossing subcostal nervure; length, 2.5-3.0 mm. *pulicarius*

Thyreocoris ater (Amyot and Serville) (PLATE II, FIGURE 2)

1811. *Tetyra helopioides* Wolff, Ic. Cim., V, 174.

1839. †*Odontoscelis unicolor* Germar, Zeitschr. Ent., I, 37.

1843. *Galgupha atra* Amyot and Serville, Hem., I, 68.

1851. †*Corimelaena unicolor* Dallas, List Hem., I, 57.

1876. †*Thyreocoris unicolor* Stål, Svensk. Vet. Handl., 14, no. 4, 23.

1878. *Corimelaena atra* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 366.

1904. †*Corimelaena unicolor* Van D., Trans. Am. Ent. Soc., XXX, 4.

1915. †*Thyreocoris unicolor* Stoner, Ent. News, XXVI, 354.

General form broadly ovate not narrowed markedly posteriorly. Color black or bronzed black and usually highly polished. Punctuation not so deep, close or uniform as in *T. nitiduloides*. Head broad, rounded, irregularly punctate except at base; anterior margin a little indented at middle; lateral margins sinuate. Antennae longer and stouter than in *T. nitiduloides*, dark reddish brown to black, the two apical segments usually darkest and noticeably longer than in *T. nitiduloides*. Rostrum dark reddish brown to black; apical segment always black; extending to posterior coxae. Pronotum convex, broad, highly polished especially on disk where the punctures are fine, sparse and shallow; punctuation denser towards

margin; the smooth margin wider and more prominent than in the following form. Scutellum broad, regularly rounded, highly polished, the disk a little less densely and more obsoletely punctured than the sides, the punctuation in general not so deep as in *T. nitiduloides*. Coriaceous portion of hemelytra entirely black; corium usually without a distinct ridge between subcostal and cubital veins and even though the ridge may be slightly evident in some specimens it is never bounded inwardly by a deeply impressed line. Venter polished, sparsely punctate on disk, heavily and thickly punctate at sides; the forward extension of the last complete ventral segment in the male is more angular and acute than in *T. nitiduloides*. Ostiolar opening prolonged into a long, raised, shiny groove; the ostiolar area dull black and heavily longitudinally striate. Legs black; femora bearing a few short spines on under surface; tibiae furnished with long, black spines; tarsi reddish brown. Length, 5.0-6.0 mm. Width across pronotum, 3.5-4.5 mm.

This is our largest and most striking species of Thyreocorid and in addition to its size it may be readily separated from our other forms by the highly polished surface on which the punctuation is not deep and by the broadly and regularly ovate form. Other and more detailed differential characters are mentioned in the preceding description.

T. ater is distributed practically throughout the state and is usually present in some numbers in any locality, particularly in more or less moist and partly shaded situations. Specimens are at hand from Ames, Chariton, Decorah, Des Moines, Dubuque, Fort Madison, Grinnell, Hills, Iowa City, Independence, Indianola, Lake Okoboji, New Hampton, Red Oak, Sac City and Storm Lake.

At Ft. Madison in late June this form was found in abundance on the few stalks of barley left standing around the edges of a field that had just been cut. Nearby plants of the ribwort (*Plantago aristata* Michx.), were also heavily infested. At Lake Okoboji in mid-August one adult and several nymphs of various sizes were found among the seeds of the painted cup (*Castilleja sessiliflora* Pursh.). Usually the species could be taken in some numbers on the blue grass along the edges of both West Okoboji and Spirit lakes.

Adults of this form hibernate successfully in our latitude for live individuals have been found as late as November 4 and in the spring as early as April 1 under rotting logs in pastures. While it has been found abundantly in a few places, great in-

crease in numbers has undoubtedly been due to local conditions and in no locality has noteworthy damage been observed.

Thyreocoris nitiduloides (Wolff) (PLATE I, FIGURE 2)

- 1802. *Cimex nitiduloides* Wolff Ic. Cim., III, 98, fig. 92.
- 1831. *Thyreocoris histeroides* Say, Descr. Het. Hem., 2.
- 1839. *Odontoscelis nitiduloides* Germar, Zeitschr. Ent., I, 37.
- 1851. *Corimelaena nitiduloides* Dallas, List Hem., I, 56.
- 1859. *Thyreocoris histeroides* Say, Compl. Writ., I, 311.
- 1876. *Thyreocoris nitiduloides* Stål, Svensk. Vet. Handl., 14, no. 4, 23.
- 1877. *Corimelaena nitiduloides* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 365.
- 1904. *Corimelaena nitiduloides* Van Duzee, Trans. Am. Ent. Soc., XXX, 5.
- 1911. *Thyreocoris nitiduloides* Zimmer, Univ. Neb. Contrib. Dept. Ent., no. 4, 27.

General form ovate, somewhat narrowed posteriorly. Color deep black, sometimes more or less bronzed and shiny. Punctuation deeper and closer than in *T. ater*. Head broad, rounded, regularly, deeply punctate except extreme base and along postero-median line; anterior margin not indented; the tylus as long as juga; lateral margins sinuate. Antennae dark yellowish brown to dark reddish brown, the two apical segments usually somewhat darker; not so heavy as in *T. ater*. Rostrum dark reddish brown to black, the distal two-thirds always black; apex acute, extending just to mid-coxae. Pronotum broad, convex, regularly, rather finely and deeply punctate so that it does not have the highly polished appearance so characteristic of *T. ater*. Scutellum broad, narrowing distinctly on posterior half, opaque black, sometimes shining but not highly polished; the sides more deeply and heavily punctured than the disk; edge of scutellum at base somewhat more deeply excavate than in *T. ater* but less so than in *T. niger*. Coriaceous portion of hemelytra entirely black, a little broader than in the preceding form; a distinct ridge on the corium between cubital and subcostal veins and running parallel with them, extends nearly from base to apex; a pronounced impressed line bounds this ridge inwardly. Venter shining, sparsely punctate on disk but densely punctate at sides; forward extension of last complete ventral segment in male more or less rounded and without median acute projection. Ostiolar region as in the preceding form. Legs black, the femora with few if any spines and the tibiae with fewer spines than in *T. ater*; tarsi reddish brown. Length, 4.0-4.5 mm. Width across pronotum, 2.7-3.5 mm.

Of our entirely black thyreocorids this is the most common and widely distributed. It may be distinguished from *ater* by the deeper and closer punctuation thus leaving a shining but not highly polished surface, the narrower form posteriorly, the deeper excavation at the base of the scutellum and the larger and heavier antennae; in addition, the present form shows a distinct ridge between the subcostal and cubital veins of the corium. From *niger* it may be separated by the more elongate and narrowed form and by the lack of transverse wrinkling on the base

of the scutellum and pronotum; the color of *niger* is a more opaque black.

Specimens of *T. nitiduloides* are at hand from Ames, Ankeny, Burlington, Chariton, Corning, Decorah, Ft. Madison, Glenwood, Granite, Iowa City, Lake Okoboji, Monticello, Red Oak, Shenandoah and Solon. Osborn also recorded the species from the state.

This form is more characteristic of the western fauna and although the records show that it is generally distributed over Iowa it is the most common in the western part of the state. At Lake Okoboji it is the most common thyreocorid of the region and is usually found in low places along the edge of woods, often on hazel, and on prairie hillside pastures. Most of the nymphs secured have been taken in July.

Thyreocoris niger (Dallas)

1851. *Corimelaena nigra* Dallas, List Hem., I, 57.

1904. *Corimelaena nigra* Van Duzee, Trans. Am. Ent. Soc., XXX, 6.

1911. *Thyreocoris niger* Zimmer, Univ. Neb. Contrib. Dept. Ent., no. 4, 27.

General form broadly ovate, widest behind thorax. Deep black to closely punctate. Head a little broader than long, rounded in front, thickly and finely punctate, the margins not sinuate. Antennae reddish brown, thickly covered with fine yellowish hairs. Rostrum reddish brown, extending to posterior coxae. Pronotum broadly rounded, thickly punctured, the punctuation more dense towards the margins; posterior half more or less transversely wrinkled; anterior angles produced forward, the lateral margins before the posterior angles slightly sinuate. Scutellum convex, the base transversely wrinkled; at either side of the base is a deep excavation which is confluent punctate; sides near the base distinctly sinuate. Hemelytra with coriaceous portion entirely black. Venter black, shining, the disk nearly smooth, the sides thickly, finely punctate. Legs black, the tibiae furnished with numerous heavy spines; tarsi yellowish brown. Length, 3.0-4.5 mm. Width across pronotum, 2.5-3.5 mm.

Three specimens which I provisionally place in this species are at hand from Glenwood and Shenandoah in southwestern Iowa. These three specimens are smaller than the average for this species and are very like *nitiduloides* except in the general form which is a little broader and more ovate than that species, in the transverse wrinkling on the bases of pronotum and scutellum and in the duller more opaque color. These transverse wrinkles which are so evident in my specimens making them quite distinct from any other form I have taken in Iowa, consti-

tute the principal reason for determining them as *T. niger*. The character of the impressed lines and punctuation mentioned by Zimmer (*l. c.* 27), I am unable to work out from the specimens at hand.

The species is more characteristic of the western fauna having been recorded from Colorado, Nebraska, Kansas, Arizona and Ontario.

Thyreocoris lateralis (Fabricius)

1803. *Tetyra lateralis* Fabricius, Syst. Rhyng., 142.

1811. *Tetyra lateralis* Wolff, Ic. Cim., V, 175.

1839. *Odontoscelis lateralis* Germar, Zeitschr. Ent., I, 39.

1876. *Thyreocoris lateralis* Stål, Svensk. Vet. Handl., 14, no. 4, 23.

1876. *Corimelaena lateralis* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 271.

1904. *Corimelaena Gillettii* Van Duzee, Trans. Am. Ent. Soc., XXX, 8.

1911. *Thyreocoris lateralis* Zimmer, Univ. Neb. Contrib. Dept. Ent., no. 4, 28.

General form broadly ovate, widest behind thorax. Deep black to bronzed, shining, distinctly and rather regularly punctured. Head short, broad, convex, very closely and uniformly punctate except a small distinct area on either side of the median line at the base; tylus a little longer than lateral lobes. Antennae reddish brown, covered with fine yellowish pubescence, the two apical segments slightly darker. Rostrum dark brown, paler at the joints; extending to posterior coxae. Pronotum black, convex, more or less shining, not narrowed so much anteriorly as in *T. pulicarius*; the surface anterior and posterior to humeral angles distinctly impressed; smooth area over the callosities large and well defined; the disk posteriorly a little less heavily punctured than in *T. pulicarius*. Scutellum sparsely, finely punctured on disk, the punctuation becoming more dense towards margins; the densely punctate depression at either side of the base is relatively shallower than in *T. pulicarius*; sinuation at sides of base not so sharp or deep as in that species. Hemelytra black with a narrow, yellowish white costal vitta extending from base to apex where it is widest; the inner black area of the coriaceous portion densely punctate; costal vitta with a few sparsely arranged brownish punctures. Venter bronzed black, moderately convex, highly polished, finely, closely punctured, the punctures a little denser towards the sides; edge of abdomen with a heavy, distinct yellowish line on the sixth segment and a similar one at the edge of the genital segment in the female; apex of sixth ventral segment in female regularly arcuated. Ostiolar canal as in *T. pulicarius*. Legs black, knees paler; tibial spines proportionately smaller than in *T. pulicarius*; tarsi yellowish brown. Length, 3.5-4.0 mm. Width across pronotum, 2.5-3.0 mm.

Of our two forms of *Thyreocoris* which have the yellowish costal margin on the corium, this is the larger. In addition, it is easily separated from *T. pulicarius*, its nearest ally in our fauna by the narrow, pale costal margin which is widest near the apex

and is not expanded at the base, by the two elongate whitish spots at the apical margin of the abdomen, by the more regular and distinct punctuation and by the large smooth area over the callosities; *lateralis* is also broader than *pulicarius*, the broadest portion being behind the thorax.

Needless to say, some variation obtains in size, punctuation and coloration. Uhler says (*l. c.*), "In Maryland, specimens sometimes occur which are destitute of the lateral pale margin; and near Baltimore may be found all the varieties between the extremes of color and punctuation." The Iowa specimens at hand do not show this extreme of variation in color but great variation in punctuation is apparent; some individuals show an almost smooth median dorsal longitudinal line.

This form is widely distributed, being found in eastern United States from Maine to southern Florida and southwest to Texas and Mexico. However, in Iowa it seems not to be common anywhere. Only about twenty specimens are at hand from the following localities: Ames, Anamosa, Iowa City, Lake Okoboji, McGregor and Solon. As is the case with the preceding forms, specimens of this species are usually found on vegetation along the edges of woods in more or less moist situations.

Thyreocoris pulicarius (Germar)

1839. *Odontoscelis pulicarius* Germar, Zeitschr. Ent., I, 39.

1851. *Corimelaena pulicarius* Dallas, List Hem., I, 59.

1851. *Corimelaena marginella* Dallas, List Hem., I, 59.

1865. *Galgupha flavomarginata* Thomas, Trans. Ill. Sta. Agr. Soc., V, 455.

1876. *Corimelaena pulicaria* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 271.

1876. *Thyreocoris pulicarius* Stål, Svensk. Vet. Handl., 14, no. 4, 23.

1886. †*Corimelaena tibialis* Uhler, Check List, 2.

1904. *Corimelaena pulicaria* Van Duzee, Trans. Am. Ent. Soc., XXX, 9.

General form ovate, widest across base of thorax. Shining black or bronzed and very closely and finely punctate. Head a little broader than long, narrowing sharply in front and with the margins slightly sinuate; closely, finely and almost uniformly punctate. Eyes reddish brown. Antennae reddish brown, covered with yellowish pubescence, the two apical segments much darker. Rostrum dark reddish brown to black, paler at the joints; extending between midcoxae. Pronotum black, shining, very convex, narrowed anteriorly, the humeri very prominent, rounded. Scutellum very convex. A deep and densely punctate oblique depression at either side of base; disk sparsely, finely punctate, the punctuation gradually becoming more dense towards margins; sides near the base rather strongly sharply sinuate. Hemelytra with base and extreme inner area of coriaceous portion

black and sparsely punctate; outer part of corium yellowish or yellowish white with small, scattered brownish punctures; pale margin of corium becoming markedly wider at base where it crosses the subcostal nervure; membrane milk-white. Venter bronzed black, convex, highly polished, sparsely punctate on disk, the number of punctures rapidly increasing towards the sides where the punctuation is very dense; usually the margin of all the segments back of the yellowish portion of the corium, the genital segment included, is pale yellowish to reddish yellow. Ostiolar area much expanded distally, roughened and not shiny; the opening itself is prolonged into a narrow, raised and shiny groove bent a little forward near the tip. Legs black, paler at the knees; tarsi reddish brown, the distal portion of the apical segment darker; tibiae furnished with fine spines arranged in rows. Length, 2.5-3.0 mm. Width across pronotum, 2.0 mm.

This is our smallest, most abundant and easiest recognized thyreocorid. It is subject to some variation in size, in width of pale margin of the corium and in the depth of color of this margin. It is our only species in which the pale margin of the corium is expanded at the base to cross the subcostal vein. The color of this margin may vary from almost white to light orange.

Localities in which this form has been secured are as follows: Ames, Anamosa, Boone, Chariton, Corning, Corydon, Des Moines, Eldora, Glenwood, Grinnell, Homestead, Indianola, Iowa City, Lake Okoboji, Shenandoah, Solon and Webster City. In fact almost any truck patch anywhere in the state should yield numbers of this species, particularly if it be located in a more or less moist situation. Uhler says of the distribution of this species (*l. c.*), "distributed over the whole length of Atlantic North America from Quebec to Florida, and westward to Louisiana and Texas."

On account of its feeding habits and its great numbers at certain favorable seasons this insect is liable to become a pest in some localities and damage has been noted and reported from time to time. Osborn recorded the species as "Abundant. Sometimes destructive to plants and often troublesome on raspberries on account of its offensive odor." (*Proc. Ia. Acad. Sci.*, I, Pt. II, 120, 1892).

On the horticultural experiment plots at Ames in June and July, 1913 *T. pulicarius* was found in abundance on potatoes. An experiment with twenty of these bugs on a potato plant in the insectary showed that the feeding punctures made by the insects caused the leaves to wilt and drop. The bugs seemed to

feed more upon the tender stems than upon the leaves of the plant.

Near Iowa City, on May 22, 1915 great numbers of this species were swept from smart weed and other low weeds growing in an unplowed strip running through the middle of a field that had been plowed a short time before. The soil here was partly sandy and had been under cultivation the previous year. Hundreds of specimens could have been taken with the sweep net in a few minutes.

At Osage the species was swept from tansy on August 12. In almost every locality visited it was taken from red clover and from fields grown up in red clover, timothy and blue grass. Uhler records it as sometimes being quite abundant "in the axils of the leaves of a species of *Eupatorium*." (Proc. Bost. Soc. Nat. Hist., XIX, 367, 1878). Often low pasture lands of blue grass and clover will yield quantities of these insects.

J. L. Horsfall submits notes which indicate that nymphs of this species were very abundant on bearding wheat at Muscatine about the middle of July, 1917. A few adults were also found at that time. The following is extracted from Mr. Horsfall's notes which he kindly submitted to me: "These nymphs were swarming on basal portions of wheat stems and on the red clover in with the wheat. No serious damage was apparent." On July 19, a few days after the grain had been cut, the bugs had left the wheat but were still present on the clover; many of the insects however, had migrated to an adjoining field of dill and were feeding upon it. Mr. Horsfall reported that at Davenport in August, 1917 great numbers of these bugs attacked the cosmos and coreopsis. He says, "They would congregate in clusters at the flower-bud then work down the stem sucking the juice so that the flower and stem would turn brown and wither. We also had them on nasturtium, snapdragon, summer lilacs, and phlox. The marigolds and late nasturtiums seemed to withstand their attacks and suffered less from them."

Undoubtedly *T. pulicarius* hibernates successfully in Iowa but I have not found living hibernating examples. My earliest spring record is April 22 but no doubt the insect is abroad before that date if the season is at all favorable. It seems to be less

hardy than *T. ater* but this deficit is made up by its extreme prolificacy.

Subfamily CYDNINAE (Dallas)

This subfamily of the Scutelleroidea contains the so-called "ground bugs" which are, as a group, quite readily distinguishable from others of the superfamily, but some of the species are separated from one another with more or less difficulty. Some of this difficulty has recently been obviated through the studies of Van Duzee who has relegated certain of Uhler's genera and species to synonymy so that the classification has been somewhat simplified. However, considerable variation obtains in punctuation, vestiture, etc., even among the individuals of a given species, thereby rendering difficult, in certain cases, satisfactory delimitation.

Most of the North American species, of which there are twenty-nine recorded are found only to the West and Southwest. All are more or less fossorial and live in sandy or semi-arid places. The principal characters of the subfamily are as follows:

Body generally oval, more or less orbicular or elliptical. Colors piceous or black. Head clypeate or semicircular. Antennae of five segments (usually) and inserted under the flat margins of the sides of the head. Second segment of rostrum usually compressed. Scutellum broad and bluntly rounded or triangular, shorter than corium and with apex depressed. Apex of corium rather broad. Generally fossorial species; tibiae beset with stout spines and usually, in addition, numerous long hairs.

Key to the tribes

Femora compressed; tibiae closely set with stout spines; anterior tibiae more or less compressed; tarsi slender, filiform; antennae usually of five segmentsCYDNINI
Femora, except anterior pair, cylindrical, sub-fusiform; tibial spines fewer and shorter; anterior tibiae not compressed; tarsi stout, second segment more slender than basal segment; antennae usually of five segmentsSEHIRINI

Tribe CYDNINI (Stål)

This tribe contains those species of the subfamily which are highly fossorial and the modifications correlated with such habits make them readily separable from our representatives in

the following subfamily. Twenty-seven species are at present recorded from North America; six of these have been taken in Iowa. The characters given in the foregoing table will suffice for ready diagnosis of this group.

Key to genera

Head with submarginal teeth

Coria of hemelytra not contiguous posterior to scutellum; the latter broadly rounded at tip; ostiolar canal enlarged into a broad lobe at tip *Cydnus* (1)

Coria of hemelytra contiguous posteriorly; scutellum triangular, convex; ostiolar canal long, linear *Amnestus* (4)

Head without submarginal teeth

Pronotum with an impressed, sinuated, antero-marginal line; ostiolar canal fusiform, transversely incised next the tip *Pangaeus* (2)

Pronotum without impressed, sinuated, antero-marginal line; ostiolar canal long, spatulate, rounded at the tip *Geotomus* (3)

Genus CYDNUS Fabricius

1803. CYDNUS Fabricius (in part), Syst. Rhyng., 184.

1851. ÆTHUS Dallas (in part), List Hem., 110 and 112.

1876. MICROPORUS Uhler, Bull. U. S. Geol. Geogr. Surv., II, no. 5, 275.

1877. MICROPORUS Uhler, Bull. U. S. Geol. Geogr. Surv., III, 373.

General form broadly oval, polished, moderately convex, hairy. Head broadly rounded, the lateral submargins armed with stout teeth and fringed with long hairs; edges sharp, recurved; tylus shorter than lateral lobes. Rostrum reaching between mid-coxae. Pronotum obsoletely transversely impressed, the anterior angles bluntly rounded, the antero-lateral margins thickly fringed with long cilia; anterior margin deeply sinuated but without submarginal impressed line. Scutellum bluntly triangular, broadly rounded at tip, the apex a little depressed. Corium short, wide, the outer angle produced backwards. Odoriferous canal short, placed very near the sternum, the outer extremity expanded into a lobe-like pit. Outer margins of venter compressed. Legs heavy, the anterior femora flattened and armed with acute spines on both outer and inner edges; anterior tibiae compressed and all the tibiae with heavy spines.

Cydnus obliquus (Uhler) (PLATE I, FIGURE 3, PLATE II, FIGURE 3, and PLATE V, FIGURE 1)

1872. *Microporus obliquus* Uhler, Rept. U. S. Geol. Surv., V, 394.

1877. *Microporus obliquus* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 373.
1882. *Cydnus obliquus* Signoret, Ann. Soc. Ent. France, II, Ser. 6, 161, Pl. 7, fig. 97.
1911. *Cydnus obliquus* Zimmer, Univ. Neb. Contrib. Dept. Ent., no. 4, 23.
1916. *Cydnus obliquus* Stoner, Ent. News, XXVII, 182.
1917. *Aethus obliquus* Stoner, Bull. Lab. Nat. Hist. S. U. I., VII, no. 3, 43.

Subovate; chestnut brown, shining, punctured, the lateral margins of pronotum and corium thickly fringed with long reddish hairs. Head short, anterior margin broadly rounded, slightly emarginate, the submargin of each lateral lobe with ten short, stout teeth and six or seven long bristles between them; the median lobe with two stout teeth; face distinctly flattened with long, oblique, punctured striae, the sides sparsely punctate with a distinct fovea next each eye and one near the tip each side of the tylus; base of head convex, impunctate. Antennae yellowish brown, second segment shortest, the third gradually becoming larger apically, the fourth and fifth distinctly moniliform, the fifth a little the longest. Rostrum of same color as antennae, reaching mid-coxae, the first segment surpassing the bucculae a little, second segment longest and heaviest, the third enlarging distally, the fourth slender and a little shorter than the third. Pronotum wider than long, irregularly, rather coarsely punctate except a crescentic area on anterior part of disk, the lateral margins oblique, densely haired, the anterior angles rounded, extended a little forward; transverse impression not distinct, the surface behind the impression rather sparsely, coarsely punctate; humeri and posterior submargin impunctate, the posterior margin a little sinuate before the lateral angles. Scutellum shining, the disk strongly punctate, the base remotely, more finely punctate, the tip depressed, angularly and bluntly rounded. Hemelytra remotely, more finely punctured, the punctures becoming still finer towards the apex; costal margin broadly curved and with ten or eleven bristle-bearing punctures; posterior margin doubly sinuate; membrane white with a tinge of brown. Wings milk-white. Venter smooth on disk, finely, longitudinally striate on sides, the lateral margins with long hairs, the entire surface with remotely placed hairs. Meso- and metasternum shiny, more or less finely striate. Ostiolar canal not extending laterally beyond the middle of the metasternal plate and terminating in a wide elevated lobe. Legs chestnut brown, heavy, the femora enlarged and with numerous long hairs; all the tibiae heavily armed with long, obliquely placed spines among which are numerous long hairs; tibiae slender, pale yellow. Length, 4.5 mm. Width at base of pronotum, 2.5 mm.

This cydnid may be at once readily distinguished from any other in our fauna by the exceedingly heavy armature of the tibiae and the numerous long hairs on the margins of pronotum and hemelytra. In addition, the shape of the ostiolar canal differs from that in any of our other representatives of the subfamily in that it terminates in a broad elevated lobe.

This fine species was first recorded from the state by the writer in 1916 (*l. c.*), numerous specimens having been taken at Iowa City the previous summer. Since that time it has been found only at Lake Okoboji, but in some numbers, so it is likely that, while the distribution is more or less localized, individuals may be met with in almost any favorable situation.

The first specimens were found on May 22, 1915 about the roots of rush grass (*Sporobolus cryptandrus* (Torr.) Gray) growing in a sandy area two miles north of Iowa City. This uncultivated area of perhaps two acres extent is near the banks of the Iowa river and supports a typically arid vegetation. In the numerous visits to this place careful search about the roots of the rush grass revealed many specimens. Sometimes as many as four adults but oftener only one or two would be found among the roots of a single plant. At no time were the insects observed walking about on the sand. Several times, specimens were found with a small seed of some kind held close to the thorax by the middle pair of legs. When the insect was freed from the sand and allowed to walk freely it still clung to the seed, progressing by means of the front and hind legs only.

On May 31, 1915 a pair of these bugs was taken in copula. In September of that year the area was inundated for several days and in early November when the place was again visited, many dead specimens were found while but two live ones were discovered. About the middle of March, 1916 careful search was again made for specimens but only two dead ones were found. However, at the next visit, on September 23, a half grown nymph was taken and many cast skins were observed. A few dead adults were found under dried grass stems at the base of the plants as well as in the sand around the roots. Subsequent observation has shown that the species has successfully maintained itself in the locality in spite of the vicissitudes of climate and flood.

In the summer of 1916 this cydnid was found in considerable numbers on the sandy beach at Gull Point on West Okoboji lake not far from the Iowa Lakeside Laboratory. On July 4 the nymphs were found to be more abundant than the adults. In all, sixty-three specimens were taken; fifty-seven of these were

nymphs, some still in the first instar, others apparently ready to molt for the last time. A number of dead adults and a single live one were also taken. The specimens were collected from among the roots of the following plants, all of which grow in considerable abundance on this sandy peninsula: beard tongue (*Penstemon grandiflorus* Nutt.) sedge (*Cyperus Schweinitzii* Torr.), wormwood (*Artemisia caudata* Michx.) and rush grass (*Sporobolus cryptandrus* (Torr.) Gray). Usually not more than three or four nymphs were found under a single plant; however, in one instance twenty-seven nymphs of different sizes were found in the sand among the roots of one small bunch of rush grass. Some of the nymphs were taken from near the bases of the stalks of rush grass and were not hidden in the sand at all but under the dead fragments of leaves and stems lying on the sand. A few specimens were found down between adjacent stalks and buried to a depth of an inch or more in the sand.

This species is most at home in the West and Southwest. The type was from Ogden, Utah and it has been recorded from Arizona, Colorado, Nebraska, California, Oregon, Texas, and I have specimens in my collection from New Mexico.

Genus PANGAEUS Stål

1862. PANGAEUS Stål, Stett. Ent. Zeit., XXIII, 95.

Body oval or oblong oval, more or less convex. Head widely rounded, the lateral lobes flat, obliquely wrinkled, with a distinct pit at the inner margin of each eye and one on each side farther anterior and not distant from the tylus; submargin destitute of teeth but with cilia; tylus wide, as long as lateral lobes. Ocelli red or reddish, nearer to the eyes than to each other. Antennae moderate, of five segments, the second segment usually shorter than the third, the fourth and fifth equal, longest and somewhat spindle-shaped. Bucculae long, parallel, enclosing entirely the basal segment of rostrum. Second segment of rostrum compressed, arched, longest; fourth segment shortest. Pronotum wider than long, narrower anteriorly than at base; surface slightly convex, the impressed line situated a little behind the middle; anterior margin deeply sinuate; just behind this sinuate margin is a groove so that a marginal ledge or thick collum is formed which becomes more slender as it approaches the antero-lateral angles; lateral submargins with a few bristles. Scutellum longer than wide, distinctly narrowed at apex. Hemelytra with costal margins a little expanded and bearing less than six setigerous punctures. Ostiolar canal elongate linear, rather flat, about half the length of the episternum, guarded by a narrow tapering scale which extends farther out than the canal itself. Anterior tibiae moderately expanded, outer margins with long, heavy teeth.

Pangaeus bilineatus (Say) (PLATE II, FIGURE 4)

1825. *Cydnius bilineatus* Say, Journ. Acad. Nat. Sci. Phila., IV, 315.
 1839. *Cydnius femoralis* H.-S., Wanz. Ins., V, 98, fig. 548.
 1859. *Cydnius bilineatus* Say, Compl. Writ., II, 242.
 1876. *Pangaeus bilineatus* Stål, Svensk. Vet. Handl., 14, no. 4, 10.
 1877. *Pangaeus bilineatus* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 386.
 1878. *Pangaeus bilineatus* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 971.
 1882. *Pangaeus bilineatus* Signoret, Ann. Soc. Ent. France, II, Ser. 6, 254, Pl. 9, fig. 113.
 1904. *Pangaeus bilineatus* Van Duzee, Trans. Am. Ent. Soc., XXX, 24.
 1911. *Pangaeus bilineatus* Zimmer, Univ. Neb. Contrib. Dept. Ent., no. 4, 24.

General form oval. Color black to deep black, highly polished; legs and rostrum paler, the antennae much paler. Head bluntly rounded and usually strongly margined; submargin with heavy, erect, remote bristles; surface of lateral lobes obliquely wrinkled; tylus usually as long as lateral lobes and with four or five shallow, transverse grooves anteriorly; base of head convex, impunctate, shining, convex. Ocelli very large, yellow or reddish. Antennae stout, yellowish brown, thickly haired, the second segment a little longer than the third. Rostrum yellowish brown, heavy, reaching between midcoxae. Pronotum gradually and moderately narrowing anteriorly, the anterior angles a little prominent, the edges reflexed and the lateral submargin with seven or eight cilia; surface moderately convex anteriorly but flatter posteriorly; transverse line on the middle distinctly impressed, sparsely, irregularly punctate, ending laterally in a more or less distinct depression anterior and posterior to which are usually large, sparsely and irregularly placed punctures; median anterior and posterior portions of pronotum without punctures; humeri rather prominent, prolonged forward into a kind of ridge; anterior submargin with a deeply impressed line. Scutellum large, slightly convex at base, somewhat depressed at apex, coarsely, sparsely, irregularly punctate; apex angularly rounded; lateral submarginal line deeply impressed, regularly and finely punctate. Corium irregularly rugulose, moderately finely, sparsely and irregularly punctate; a single row of punctures on either side of the cubital vein; punctures on and near clavus regular, coarser; costal margin with three or four bristle-bearing pits; membrane yellowish brown and considerably longer than abdomen. Venter smooth, impunctate, the posterior edges of the segments either side of median line finely serrate; connexivum rough and uneven; last complete ventral segment in both sexes with a long bristle on each side of median line near apex. Ostiolar canal large, covered in front by a convex ridge which is indented on the posterior margin near the tip leaving a small angulate lobe at the extremity; ostiolar plate concave and very finely rugulose on internal three-fourths. Legs reddish-black; anterior femora distinctly enlarged, somewhat angulate; anterior tibiae moderately expanded, the upper surface with transverse depressions; outer edge with eight or nine long curved spines, the tip with three or four and the inner margin near the apex with a very long, slender oblique one; middle and posterior tibiae rather closely and

irregularly set with very long and strong black spines; tarsi very slender, pale clay yellow. Length, 6.5-8.0 mm. Width across pronotum, 3.25-4.50 mm.

This form, as indicated by both Uhler and Signoret, varies considerably in some of the structural characters. Some specimens show a slight emargination of the head in the antero-median line; sometimes the second antennal segment is longer than the third but usually the third segment is the longer; the number of bristle-bearing punctures on the costal margin of the corium varies from three to five, three being the usual number; the number of spines on the outer edge of the anterior tibiae varies from eight to nine in my specimens; Uhler says there are "about ten"; the ostiolar canal and plate vary somewhat in length and width; the posterior border of the canal is more deeply and irregularly incised in some specimens than in others, while the extent of the finely rugose area of the ostiolar plate also varies in extent. In fully mature specimens the general color is a rather deep shining black but other more or less immature specimens are a deep mahogany brown. The males average somewhat smaller than the females.

This is the only Iowa representative of the genus and in the light of our present knowledge concerning the distribution of our Cydninae, may be known by the fact that it is the largest Iowa species. While it enjoys a wide distribution from Connecticut west to Texas and Mexico it seems to be rare in the state since but a single specimen has been found at Burlington. Professor Osborn listed one specimen from Adams county in southwestern Iowa. These are the only Iowa records known to me at the present time.

Genus GEOTOMUS Mulsant and Rey

1866. GEOTOMUS Mulsant and Rey, Punaisses de France, 34.

Although this genus is represented in our fauna by but a single species it is, nevertheless, a very extensive one, widely distributed in the Neotropical, Palaearctic, Oriental and Australasian regions. It may readily be distinguished from our other Iowa genera by the following combination of characters: no spines on head; no impressed submarginal line on anterior part

ostiolar canal terminated by a broad, rounded lobe. The more detailed differential characters are also herewith appended:

Elongate oval. Head widely rounded, the margin narrowly recurved, with sparse hairs only; tylus as long as lateral lobes; bucculae rather widely separated anteriorly, gradually becoming higher posteriorly and enclosing the first segment of the rostrum which reaches nearly or quite to mid-coxae; second segment of rostrum longest, the third segment longer than the fourth. Antennae with basal segment stouter than the second segment, a little reduced at tip; second segment slender, either longer or shorter than third which is thickened towards tip; fourth longer, fifth longest, both subfusiform. Pronotum wider than long, slightly convex, the lateral margins almost straight, the edges recurved; anterior margin broadly sinuate, the posterior margin nearly truncate. Scutellum longer than broad, sharply narrowing towards apex, the tip narrow, acute. Hemelytra broad, depressed; apical portion of costal margin curved thus exposing the posterior part of the connexivum; posterior margin oblique, slightly arcuated. Ostiolar canal long, slender, about two-thirds the length of episternum and with a broad, rounded lobe at tip. Legs normal, the anterior tibiae only moderately expanded.

As suggested by Signoret (Ann. Ent. Soc. France, III, Ser. 6, 33, 1883), most of the characters of the genus are more or less negative but "..... on voit que les *Geotomus* s'en séparent très facilement et offrent de particulier que, sans aucun caractère réel, on peut cependant très bien les considérer comme constituant un bon genre."

Geotomus robustus (Uhler) (PLATE V, FIGURE 2)

1877. *Melanaethus robustus* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 390.

1883. *Geotomus robustus* Signoret, Ann. Soc. Ent. France, III, Ser. 6, 59, Pl. 4, fig. 168.

1904. *Geotomus robustus* Van Duzee, Trans. Am. Ent. Soc., XXX, 25.

1911. *Geotomus robustus* Zimmer, Univ. Neb. Contrib. Dept. Ent., no. 4, 24.

1916. †*Geotomus parvulus* Stoner, Proc. Ia. Acad. Sci., XXIII, 304.

Widely oval, somewhat flattened above. General color deep black, somewhat shining; apices of hemelytra deep brownish black. Head broad, densely punctured, depressed near anterior margin which is almost regularly semicircular with the edge elevated; occiput smooth. Antennae stout, reddish brown, the segments darker at the middle; second segment slightly shorter than third; fourth segment longer than third and fifth segment longest. Rostrum reddish brown, reaching mid-coxae; second segment longest, fourth shortest. Pronotum a little narrowed and rounded anteriorly, the surface closely, coarsely punctured except on disk which is almost smooth; transverse impression faint, distinct only at sides; anterior submargin with a row of fine punctures but the margin itself is impunctate; humeri and posterior submargin elevated. Scutellum long, broad, basal portion remotely, rather coarsely punctate, the disk feebly

punctate, more finely and closely punctate towards tip which is narrow, depressed and extends beyond the inner border of the corium. Hemelytra wide, shining black and coarsely punctured at base; tinged with rufous and more finely and closely punctured near tip; marginal area very large and finely punctate; membrane white tinged with brown at base. Venter black, shining; faintly, finely and sparsely punctured on disk, the sides more deeply punctured, often minutely wrinkled. Side pieces of prothorax coarsely punctured, the other thoracic plates polished, impunctured. Ostiolar canal long, the tip ending in a rounded lobe. Legs shining black, the tarsi pale testaceous; tibiae furnished with many long, slender spines arranged in whorls. Length, 3.75-4.25 mm. Width across pronotum, 2.0-2.25 mm.

This is the smaller of our two black cydnids and is also our only representative of the Cydnini which is shining black; in addition, it may be distinguished from our other species by its broadly ovate form and the long ostiolar canal the tip of which is covered by a rounded lobe.

This cydnid, the only Iowa representative of the genus, was first recorded from the state by the writer as *Geotomus parvulus* Signoret (*l. c.*), two specimens bearing labels with the following data having been discovered in the collection of the Iowa State Agricultural College: "Exp. Sta., 5-18-'97, Ames, Ia." However, after further study of these specimens I am compelled to retract my former determination and to refer them to *G. robustus* Uhler. Although they differ in some minute details from Uhler's description and Signoret's figures of *robustus*, the form, punctuation and size place them in that species while the shape of the ostiolar canal more nearly approaches that of *parvulus*. But in the other specimens of undoubted *robustus* that I have examined the ostiolar canal varies somewhat so that the weight of evidence favors the placing of these specimens in *robustus*. The known distribution of this species also suggests the likelihood of its occurrence in Iowa.

While the legend quoted above does not necessarily indicate that the specimens were taken in Iowa it is reasonable to infer that they were. As suggested in my previous paper, this may possibly be the species to which Professor Osborn referred in the Proceedings of the Iowa Academy of Science, Volume V, 1897, page 232 where he lists "*Geotomus sp.*" from Iowa. No other records of this form are at hand.

Genus AMNESTUS Dallas

1851. AMNESTUS Dallas, List Hem., I, 110 and 126.

This is one of the smaller genera of Cydninae, eight forms only being mentioned by Signoret. Three forms have been recorded from North America all of which have also been found in Iowa. The members of the genus are common to the Nearctic and Neotropical regions and are most at home in more or less sandy situations. The principal generic characters follow:

Body subquadrate, more convex below than above. Head small, longer than broad; anterior margin semicircular, armed with short, stout teeth, four of which are on the tip of the tylus which is longer than the jugs. Eyes large, prominent. Second antennal segment very small, slender, the fourth and fifth segments long and very slenderly articulated. Rostrum very long and slender, the basal segment longer than the bucculae which are short and somewhat rounded. Pronotum a little wider than long, the anterior portion of the disk convex, the anterior angles broadly rounded; a transversely impressed line behind the middle. Prosternum raised and bounded on either side by a broad arched plate. Ostiolar canal long, slender, extending almost to outer margin of episternum, the sides elevated. Scutellum small, triangular, equilateral, the tip acute. Corium short, broad, the posterior margin sinuate, the costal margin arcuate towards apex; membrane very long, white, surpassing the abdomen and with two to four indistinct longitudinal veins. Legs slender, not closely spined; tarsi short, slender and pubescent; anterior tibiae enlarged and compressed at tips; a single row of stout spines on outer edge, gradually increasing in size towards apex which is furnished with four spines; several slender and very oblique teeth along inner margin on the under side; apical half of anterior femora distinctly enlarged.

Key to the species

Form somewhat more convex; color darker; length, 3.5-4.5 mm. *spinifrons*

Form less convex; color paler; length, 2.0-2.75 mm.

Juga each with four spines *pusillus*

Juga each with five spines *pallidus*

Amnestus spinifrons (Say) (PLATE II, FIGURES 5, 7 and 8, and PLATE V, FIGURE 3)

1883. *Amnestus spinifrons* Signoret, Ann. Soc. Ent. France, III, Ser. 6, 367, Pl. 10, fig. 192.

1911. *Amnestus spinifrons* Zimmer, Univ. Neb. Contrib. Dept. Ent., no. 4, 23.

1877. *Cydnus spinifrons* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 370.

1825. *Cydnus spinifrons* Say, Journ. Acad. Nat. Sci. Phila., IV, 316.

1876. *Amnestus spinifrons* Stål. Svensk. Vet. Handl., 16, no. 4, 21.

1859. *Cydnus spinifrons* Say, Compl. Writ., II, 242.

1851. *Amnestus spinifrons* Dallas, List Hem., I, 126, Pl. 3, fig. 2.

Elongate, subquadrate, densely punctured except disk of pronotum. General color chestnut brown, the legs, rostrum and antennae yellowish to yellowish brown. Head longer than wide, irregularly ciliated along the border, coarsely, irregularly punctured, the tylus longer than the juga, gradually narrowing posteriorly and bearing at the tip four strong teeth; juga each bearing five teeth. Antennae slender, the second segment very small and paler than the others; third segment slender at base but enlarged apically and longer than any of the others; fourth and fifth slender, subequal and attached by very slender bases. Rostrum long, slender, reaching between or posterior to hind coxae; basal segment slightly longer than head; second segment longer, heavier, compressed, finely hairy; third segment longest, slender, finely, sparsely haired; apical segment slender, about same length as second. Pronotum a little wider than long, the anterior angles strongly rounded, the sides convex, slightly sinuate in front of the posterior angle; margins recurved and with six or seven bristles; anterior margin not deeply sinuate; impressed submarginal line narrow and smooth; posterior margin slightly arcuated, high and convex, a little sinuated just interior to humeral angles; surface shiny; punctuation on disk of anterior lobe very sparse and fine; punctuation along anterior submargin and sides rather fine and very dense; a transverse indented line on the middle behind which the punctuation is close and coarse, the posterior submargin with the punctures finer and more remote. Scutellum short, triangular, convex, remotely, not strongly punctate, with a submarginal impressed line in which the punctures are arranged in a single row. Hemelytra a little paler than pronotum, highly polished, deeply and closely punctate except middle of posterior half of corium; apex markedly sinuate; external angle surpassing the abdomen; punctures of clavus arranged in three rows; membrane white, extending much behind abdomen. Venter polished, very finely punctate and clothed with yellowish pubescence. Ostiolar canal very long, high and narrow with the anterior border slightly convex; situated on the dark brown rugose episternum. Metepimera produced backwards over base of abdomen in the form of flaps. Meso- and metasternum strongly grooved longitudinally. Legs pale reddish brown; anterior femora of female with an oblique, bifid tooth beneath; middle femora unarmed; posterior femora with a heavy, blunt spine beneath near the tip; femora of male unarmed; both sexes with anterior tibiae greatly expanded and flattened at the tip; outer edge with nine or ten spines, the tip with four, the internal face with five or six; middle and posterior tibiae with stiff spines on the exterior edge; posterior tibiae long, slender, slightly curved. Length, 4.0 mm. Width across pronotum, 2.0 mm.

This is the largest and darkest colored of our three species of *Amnestus*, though it is subject to a little variation in both size and color. The femora of the female are more fully armed than those of the male, both anterior and posterior pairs in the female

being furnished with conspicuous spines. The spines on the anterior femora are peculiar in being bifid at the apex. This armature is entirely lacking in the male.

But five specimens of *A. spinifrons* are at hand from Iowa; two of these are from Iowa City and were taken March 20 and April 21 respectively; the other three specimens are from Lake Okoboji; two of these were taken in June, the other in July. They were swept from blue grass on the sandy knolls immediately to the south and west of the Iowa Lakeside Laboratory. Although extended and persistent effort has been put forth in looking for these insects in presumably favorable situations such as sand blowouts and ridges, beneath bark and leaves in sandy places and about the roots of various plants in such areas our searches have been almost in vain. Professor Osborn recorded the species from Ames and indicated its status in the state as rare. It is found over practically the entire United States as far west at least as Texas and Colorado. Say's type came from Missouri. Zimmer (*l. c.*) records but a single specimen from Nebraska.

Amnestus pusillus Uhler (PLATE II, FIGURE 6)

1876. *Amnestus pusillus* Uhler, Bull. U. S. Geol. Geogr. Surv., II, no. 5, 278.

1877. *Amnestus pusillus* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 371.

1883. *Amnestus spinifrons* Signoret, Ann. Soc. Ent. France, III, Ser. 6, 367, Pl. 10, fig. 197.

1895. †*Amnestus subferrugineus* Gillette and Baker, Hem. of Colo., 11.

1904. *Amnestus pusillus* Van Duzee, Trans. Am. Ent. Soc., XXX, 25.

1911. *Amnestus pusillus* Zimmer, Univ. Neb. Contrib. Dept. Ent., no. 4, 25.

Form of *A. spinifrons* but not quite so convex above and the entire surface is more uniformly, finely and densely punctured. General color pale reddish brown, the legs, rostrum and antennae pale yellowish. Head rounded in front, longer than wide; tylus longer than juga and furnished with four long teeth. Antennae slender, the second segment minute, the third, fourth and fifth segments united by very slender processes. Pronotum proportionately narrower anteriorly than in *A. spinifrons*, rather densely, coarsely punctured over the entire surface, the transverse groove deeply impressed, not reaching to the margins; humeri and posterior margin more finely punctured; antero-lateral margins distinctly paler than remainder of upper surface. Scutellum closely punctured, small, triangular with apex sharply pointed; a submarginal impressed line in which the punctures are regularly arranged. Hemelytra distinctly paler than pronotum, closely, finely punctate except on disk; corium distinctly sinuate at apex; external angle scarcely surpassing the abdomen; membrane white, surpassing the abdomen but much shorter than corium. Venter

pale yellow to reddish brown, finely rugulose and covered with fine, yellowish, decumbent hairs. Ostiolar canal long, somewhat sinuate, reaching almost to lateral margin of metasternum, distinctly raised above the level of the large rugulose place upon which it rests. Legs pale yellow or reddish yellow, the anterior femora unarmed in the male but in the female they are furnished with an oblique, bifid tooth on the under side similar to that in *A. spinifrons*; middle and posterior femora of male unarmed but in the female the posterior femora bear a long, slender spine; anterior tibiae of both sexes slightly compressed but not flattened as much as in *A. spinifrons*, furnished with five long, slender dark-colored spines on the outer side and with two or three at the apex; middle and posterior tibiae long, slender and with long spines. Length, 2.0-2.5 mm. Width across pronotum 1.0-1.5 mm.

In general this form may be said to be a small edition of the preceding, the character of size being the most obvious difference between them. In addition, the present species averages paler in color, somewhat less convex in form and more uniform in punctuation than *A. spinifrons*.

In the many specimens of *A. pusillus* which I have had for examination from various parts of the country the females, without exception, bear a bifid tooth on the under side of the anterior femora although Uhler, in his original description (*l. c.*) says, "It lacks the femoral tooth which is so conspicuous in *A. spinifrons*." Again (*l. c.*), 1877, he says, "No specimens have yet been seen to have the forked tooth on the anterior femora." In addition, the possession by the females of a large pointed spine on the posterior femora is noteworthy and that character also holds in all the examples of this sex examined by me. Females of *A. pallidus*, the following species, have this latter character developed to only a slight degree.

Amnestus pusillus seems, in general, to be more common in the United States than *A. spinifrons* but I have only two Iowa specimens in my collection; one is from Iowa City, collected in June and a single specimen from Lake Okoboji was taken in July. The specimens were swept from vegetation in more or less sandy situations. Although extended search has been made in the earth and sand in presumably proper habitats our efforts have not met with much success. Professor Osborn recorded the species from Ames.

Amnestus pallidus Zimmer

1910. *Annectus* (sic) *pallidus* Zimmer, Can. Ent., XLII, 166, fig. 10.
1911. *Amnestus pallidus* Zimmer, Univ. Neb. Contrib. Dept. Ent., no. 4, 25.
1917. *Amnestus pallidus* Parshley, Occ. papers Bost. Soc. Nat. Hist., VII, Fauna N. Eng., 14, 16.

Form of *A. pusillus* but more sparsely, coarsely punctate. General color pale yellowish brown. Head coarsely punctate, rounded in front, the tylus slightly longer than juga and with four heavy terminal teeth; juga each bearing five teeth. Antennae yellowish brown, second segment minute, third segment longest, four and fifth subequal. Pronotum with transverse impressed line distinct and closely, coarsely punctured; back of this line to the posterior submargin the punctures are sparse and coarse; anterior half of pronotal margins convex, the posterior half distinctly concave; disk of pronotum finely punctate; a submarginal row of small punctures along anterior edge. Scutellum coarsely, sparsely punctate, a transverse impressed line separating the basal impunctate portion from the rest; a submarginal impressed line in which the punctures are regularly and closely arranged. Hemelytra paler than pronotum, more sparsely punctate than in *A. pusillus*, the disk impunctate; corium deeply trisinate at apex, the external angle surpassing the abdomen and more pointed than in *A. pusillus*. Venter reddish yellow, finely punctate and thickly covered with fine, yellowish decumbent hairs. Ostiolar canal about as in *A. pusillus*. Legs yellowish to yellowish brown, the anterior femora of the female with a large bifid tooth as in *A. spinifrons*; anterior tibiae moderately expanded, thickly haired and with five large teeth on outer side; all the tibiae more thickly haired than in *A. pusillus*. Length, 2.0-2.75 mm. Width across pronotum, 1.0-1.5 mm.

In Zimmer's original description (*l. c.*) this species is, presumably through a typographical error placed in the genus "*Annectus*" but obviously this is a mistake since the form unquestionably falls in the genus *Amnestus*. In Zimmer's later paper on the Pentatomidae of Nebraska (*l. c.*) the error is corrected.

Amnestus pallidus is very similar to *A. pusillus*, the most obvious difference between the two forms being the presence of five teeth on each jugum in *pallidus* while in *pusillus* there are but four.

Two specimens of this form which is here recorded from the state for the first time are at hand from Iowa City; both were taken in June. One specimen was swept from plantain-leaved everlasting (*Antennaria plantaginifolia* (L.) Rich.). Zimmer's type was from Nebraska. Parshley (*l. c.*) has recently recorded

this form from Massachusetts and Connecticut and I have a specimen in my collection from Illinois.

Tribe SEHIRINI (Stål)

The members of this tribe are not so highly fossorial as are those of the tribe Cydnini as has been indicated by some of the characters given in the preceding key. Two genera, each containing a single species, are found in North America and but a single genus and species is found in Iowa.

Genus SEHIRUS Amyot and Serville

1843. SEHIRUS Amyot and Serville, Hém, 96.

Oval, somewhat flattened above, head long, the lateral lobes oval curving broadly upward, a little longer than tylus but not meeting in front thus leaving the head somewhat emarginate; neither spines nor bristles on head. Antennae long, slender, pubescent; basal segment shortest, stout; fifth segment longest, the fourth and fifth slenderly attached and subfusiform. Rostrum slender, reaching to midcoxae; basal segment short, entirely enclosed by bucculae; second and third segments longer, subequal, fourth segment short, equal to first. Pronotum somewhat flattened, the margins thickened and recurved, the transverse impressed line apparent. Scutellum long, sharply narrowed towards tip, the apex depressed, rounded, the base convex. Corium with posterior margin subtruncate, slightly sinuate next the interior angle; membrane thicker at base than at apex, with four or five nervures two of which are forked at the tip. Connexivum thickened at edge, slightly decurved. Ostiolar plate elongate, depressed, tapering towards outer end, slightly curved, the convex side posterior; opening large and at extreme inner end of plate. Anterior tibiae a little thickened at tip, the inner side with a broad groove bordered by short, nearly prostrate spines, the outer side and tip with longer and heavier spines.

Sehirus cinctus (Palisot de Beauvois) (PLATE I, FIGURE 4,

PLATE II, FIGURE 9 and PLATE V, FIGURE 4)

1805. *Pentatoma cincta* Pal. Beauv., Ins. Afr. Amer., 114, Hem., Pl. 8, fig. 7.

1831. *Cydnus ligatus* Say, Descr. Het. Hem., 10.

1851. *Sehirus albonotatus* Dallas, List Hem., I, 127.

1859. *Cydnus ligatus* Say, Compl. Writ., I, 322.

1864. *Sehirus cinctus* Stål, Hem. Afr., I, 29.

1876. *Canthophorus cinctus* Stål, Svensk. Vet. Handl., 14, no. 4, 22.

1877. *Sehirus cinctus* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 397.

1884. *Canthophorus cinctus* Signoret, Ann. Soc. Ent. France, IV, Ser. 6, 60, Pl. 3, fig. 227.

1904. *Sehirus cinctus* Van Duzee, Trans. Am. Ent. Soc., XXX, 26.

Broadly ovate; shining, piceous-black or blue-black, punctured. Head long, emarginate in front, the lateral lobes curved upwards, the lateral margins reflexed, without spines or bristles, finely, confluent punctured

anteriorly, the vertex raised and smooth. Antennae slender, blackish, the second segment paler, the first segment stout, shortest, the apical segment longest. Rostrum slender, blackish, reaching to midcoxae. Pronotum with anterior lobe smooth, impunctured, the remainder of its surface except posterior margin and thickened, white lateral edges deeply, coarsely and somewhat irregularly punctured; transverse impressed line broad but not reaching the lateral margins which obliquely approach the head thus rendering the pronotum distinctly narrower anteriorly than at base. Scutellum shining, coarsely, remotely punctured on middle, the punctures along the margin more or less confluent; extreme tip somewhat impressed and broadly rounded. Corium coarsely, rather regularly punctured, the punctures a little larger and denser at the base, shallower and finer on the posterior part of the disk; costal margin narrowly edged with white; a smooth crescent-shaped white mark is often present near the postero-lateral angle; posterior margin subtruncate, a little sinuate near the inner angle; membrane brown, the base thickened towards the inner angle; apical margin thinner, paler; five veins more or less plainly visible, two of which are sometimes forked at the tip. Venter deep black, shining, moderately convex, the sides very densely and moderately finely punctate, the disk very finely and sparsely punctate; edge of connexivum smooth, white at least on three apical segments, sometimes on all the segments. All the sternal plates shining but the odoriferous apparatus is dull black; the ostiole is very small and opens into a narrow groove which gradually becomes evanescent laterally; the groove is situated on a raised, crescentic and spatula-like plate which reaches three-fourths the distance from the ostiole to the margin; the plate is convex on the posterior border and rounded at the extremity. Legs black, the tibiae with a smooth white streak on outer side and with weak and rather sparsely placed spines arranged in rows; tarsi piceous, thickly set with yellowish hairs; coxae subtransversely striate. Length, 4.0-7.0 mm. Width across pronotum, 2.5-3.5 mm.

This species is subject to some variation, both sexual and individual. The emargination on the front of the head varies among individuals of the same sex but is usually less distinct in the males. Often the males lack the white spots on the corium but these spots are also sometimes lacking in the females. Indeed, the extent and shape of this white spot, even when present, seems to be very variable. The forking of the veins of the membrane also varies much, some specimens having two veins distinctly forked at the tip while other specimens do not show this character.

However, with all its variation, this species is most easily recognized of all our *Cydinae* by its uniform bluish-black color

with white pronotal and costal margins and the abbreviated white lines on the outer sides of the tibiae.

Sehirus cinctus as a species is widely distributed in the United States, Canada and Mexico, and in Iowa is one of the most widely distributed members of the subfamily although nowhere can it be said to be more than locally common. Specimens are at hand from Forest City, Grinnell, Iowa City and Lake Okoboji.

As with many other cydnids, this form is usually found in low sandy places near water. A specimen from Grinnell was swept from a raspberry bush. At Lake Okoboji two specimens were swept from the blue grass and timothy growing on a low cleared space near the woods. The Forest City specimens were swept from low weeds growing on the banks of a freshly constructed drainage ditch. One Iowa City specimen was taken from wild cherry.

This species hibernates successfully in Iowa for at Iowa City on March 21, 1913, while the frost was still in the ground, living specimens were collected from under sticks and boards in a meadow which had been used as a pasture during the previous summer. On April 16, 1913, a single specimen was taken at Iowa City from under a small rock at the edge of the Iowa river.

Again at Iowa City on March 25, 1916 several specimens were found under the leaves and in the grass along the sides of a large piece of sawed timber lying in a sandy pasture near the river. Other specimens were found buried in the soil to a depth of an inch and the soil in turn was covered with dead leaves. Remains of dead specimens were also found which showed that at least a goodly number of the bugs that had chosen this shelter had not been able to survive the rigors of an Iowa winter. On April 1, 1916, near the same locality where the above specimens were secured, a single live individual was taken from under the loose bark of a fallen cottonwood tree.

Family PENTATOMIDAE (Leach)

This is the largest and most cosmopolitan family of the Scutelleroidea and contains the greater share of our well known forms. In general, the Oriental, Ethiopian and Tropical regions

of America have the best representation with the Australasian region showing the smallest proportionate number. Considerable variation in size, form and coloration as well as in food habits obtains in the family which, in North America, is readily separable into three distinct subfamilies and totals about two hundred forms; forty-seven forms are herewith recorded for Iowa. Following are the chief diagnostic characters:

Scutellum usually moderate in size and more or less narrowed towards apex; in a few cases the scutellum covers most of the abdomen and under these circumstances the colors are sharply contrasted or else a prominent tooth is present just anterior to the lateral angles of the pronotum. Primary and subtended veins of wing contiguous or subcontiguous, diverging apically; hamus not present. Veins of membrane arising near the interior basal angle or springing from a vein which begins at this angle and runs parallel to the margin of the corium; corium obtuse at apex. Basal segment of venter very distinct, at least towards sides. Connexivum of abdomen with seven visible dorsal segments. Tibiae rarely strongly spinose, often unarmed. Tarsi 2- or 3-segmented.

Key to the subfamilies

Bucculae long, parallel or subparallel; rostrum inserted a little behind tip of tylus; basal segment of rostrum usually slender and largely embedded between bucculae

Scutellum almost covering abdomen, broad at tip; frena very short; pronotum with a single prominent tooth anterior to lateral angles.....GRAPHOSOMATINAE

Scutellum smaller, more or less narrowed at apex; frena longer; pronotum either without teeth or with numerous teeth near antero-lateral angles...PENTATOMINAE

Bucculae small and converging posteriorly under rostrum; rostrum inserted near tip of tylus; basal segment of rostrum short and thick.....ASOPINAE

Subfamily GRAPHOSOMATINAE (Jakovlev)

But three genera of this rather distinct subfamily which is mainly Palaearctic and continental in distribution are found in North America. The North American forms are all small, dark colored and of a roughened appearance. Two species of the subfamily are here recorded for Iowa.

Head long, lateral margins sinuate; juga broad at apex, equalling or exceeding tylus; eyes prominent and stylated. Pronotum with anterior angles produced into a tooth or lobe; humeral angles emarginate and with

a tooth anterior to the sinus. Scutellum large, almost entirely covering the dorsal part of abdomen; frenum usually very short.

Tribe PODOPINI (Dallas)

Head produced, forming a triangle with the prothorax, its central lobe generally reaching the anterior margin. First segment of rostrum not extending beyond bucculae. Eyes prominent and more or less pedunculated. Antennae with fifth segment incrassate, about twice as heavy as the fourth; second segment shorter than third; apex of antennal tubercles produced into a somewhat obtuse, slightly acute process. Thorax hexagonal. Margins of scutellum parallel. Hemelytra straight, not folded in at base of membrane, the outer part of the coriaceous portion exposed. Frena absent or very short.

Three North American genera are placed in this tribe while but one of these occurs in Iowa.

Genus PODOPS Laporte de Castelnau

1832. *PODOPS* Laporte de Castelnau, Essai. Classif. Syst. Hém., 72.

Apex of antennal tubercles conspicuous beyond sides of head and armed with a curved spine. Juga thin, a little longer than tylus. Anterior angles of pronotum armed with a short acute tooth.

Subgenus Amaurochrous Stål

1872. *Amaurochrous* Stål, Svensk. Vet. Handl., 10, no. 4, 15.

Key to the species

Lateral tooth of pronotum large, obtuse, the anterior margin arcuate; tylus somewhat elevated towards apex; juga less concave dorsally; size larger; length, 6.5–7.0 mm... *cinctipes*

Lateral tooth of pronotum short, acute, the anterior margin nearly straight; tylus less elevated towards apex, the juga more nearly contiguous over its depressed tip; size smaller; length, 5.0–5.5 mm..... *parvulus*

Podops cinctipes (Say) (PLATE V, FIGURE 5)

1828. *Tetyra cinctipes* Say, Amer. Ent., III, 94, Pl. 43, lower right fig.

1839. †*Podops dubius* Germar, Zeitschr. Ent., I, 64.

1839. †*Podops dubius* H.-S., Wanz. Ins., V, 44, fig. 495.

1859. *Tetyra cinctipes* Say, Compl. Writ., I, 94, Pl. 43, fig. 4.

1867. *Scotinophara cinctipes* Stål, OEfv. Vet. Ak. Förh., XXIV, 502.

1872. *Podops cinctipes* Stål, Svensk. Vet. Handl., 10, no. 4, 15.

1904. *Podops cinctipes* Van Duzee, Trans. Am. Ent. Soc., XXX, 22.

Body elongate oval, narrowed behind, somewhat flattened, more convex below than above. Color above dull testaceous to brownish with rather

large, regular and closely set punctures; color beneath black. Head black, strongly carinate, thickly punctured and with a somewhat rugose appearance; juga explanate, slightly concave dorsally, a little longer than the elevated tylus thus leaving the apex of the head emarginate. Antennae brownish, the apical segment dilated and darker, the second and third segments not sharply differentiated. Rostrum reaching to midcoxae; second segment pale yellow, the third brownish and tip of apical segment piceous. Pronotum rather regularly, deeply punctate, a pale impunctate, median longitudinal line extending backwards from anterior margin to or almost to posterior margin; three blunt tubercles on the anterior submargin, the median one pale and sometimes almost obsolete; a median transverse furrow deeper towards the middle and an anterior furrow very near the fore border which is not much elevated above the base of the head; humeral tooth obtuse, somewhat rounded and projecting slightly forward, the anterior margin arcuate; anterior angles with a small tubercle. Scutellum covering almost entire abdomen leaving the sides and tip uncovered; base with a pale calloused spot either side. Venter black, closely punctured except on disc which portion of the sixth visible ventral segment is almost smooth; incisures with pale points. Basal part of genital segment of male short, punctured, the outer apical angles produced into narrow, obtuse lobes projecting beyond apex of scutellum; inner and median genital plates of female short with a median sinus at apical margin. Tibiae and anterior femora blackish with one or two yellowish bands; middle and posterior femora pale with two bands and base blackish; tarsi pale brown. Length, 6.5-7.0 mm. Width across pronotum, 4.0-4.5 mm.

The larger size, large obtuse humeral tooth with arcuate anterior edge, distinctly elevated tylus, the nearly smooth disc of the posterior segment of the venter and the generally darker colors will serve to separate this species from the following. The differences in the genital segments are also quite pronounced.

Professor Osborn recorded this species as "rare" in Iowa and gave but one locality "Ames." We have collected only a few specimens from Davenport, Chariton, Lake Okoboji and Iowa City. While the species is nowhere abundant it is generally distributed over the state and is likely to be met with in almost any locality. It has usually been found in damp situations on long grass or weeds in the vicinity of ponds or creek bottoms. It seems to hibernate more or less successfully in this latitude since some of the Iowa City specimens have been taken early in May.

Podops parvulus Van Duzee (PLATE V, FIGURE 6)

1904. *Podops parvulus* Van D., Trans. Am. Ent. Soc., XXX, 22.

1911. *Amaurochrous parvulus* Zimmer, Univ. Neb. Contrib. Dept. Ent., no. 4, 20.

1915. *Podops parvula* Parshley, Psyche, XXII, no. 5, 171.

1917. *Podops parvulus* Stoner, Bull. Lab. Nat. Hist. S. U. I., VII, no. 3, 44.

Body elongate-oval, not so distinctly narrowed behind as in *P. cinctipes*.

Color above averaging lighter and the punctuation a little finer than in that species; color beneath black. Head black, deeply punctate, the tylus slightly shorter than the lateral lobes and less strongly elevated than in *P. cinctipes*; juga almost contiguous. Eyes stylated, slender. Antennae shorter than in *P. cinctipes* the second and third segments more strongly differentiated than in that species. Rostrum with basal segment piceous, second segment pale yellow, two apical segments fuscous, the incisures pale yellow. Pronotum with anterior furrow further removed from anterior border than in *P. cinctipes*, this border raised more above the base of the head and the median transverse furrow is more uniform than in that species; humeral tooth short, acute, produced downwards and backwards, the anterior margin nearly straight; anterior angles with a small pointed tubercle. Scutellum deeply, quite uniformly punctured, the areas between the punctures testaceous; a yellowish calloused spot at the outer anterior basal angles. A more or less distinct median, calloused, impunctate longitudinal line continuous with a similar line on the pronotum is continued backwards to near the apex of the scutellum. Venter black, deeply, almost uniformly punctured to apex; incisures with pale points; basal part of genital segment of male long, punctured; the apical sinus broad and shallow, the outer apical angles rounded and not prominent. In the female the inner and median plates almost attain the line of the outer plates. Femora and tibiae blackish with one or two pale bands; first and second tarsal segments pale yellow, third and the claws brownish or piceous. Length, 5.0-5.5 mm. Width across pronotum, 3.0-3.5 mm.

The small size, the distinctly explanate juga, the less elevated apex of the tylus and the short acute humeral tooth will serve in differentiating this species. In addition, all my specimens show a more or less definite median, calloused longitudinal line on the scutellum which extends nearly to its apex.

This species was first recorded in the state from the Lake Okoboji region by the writer in 1917 (*l. c.*). Indeed, it proved to be more common in that locality than the preceding species and was found in similar situations. Specimens are also at hand from Estherville and Solon.

The ostiolar area of our two species of *Podops* is very similar but differs in appearance from that of any other Iowa representatives of the Scutelleroidea. The orifice is well outside and

a little behind the midcoxae. It is not prolonged into a single groove but a number of crenulated ridges radiate in a fan-shaped pattern from the opening and terminate abruptly at the outer one-third of the metapleurae, thus forming a series of grooves.

Subfamily PENTATOMINAE (Stål)

This subfamily is very widely distributed, attaining its greatest development in point of size, coloration and numbers in the tropical parts of the Old World. It is also the best represented subfamily in the New World and in North America it is made up of about 150 forms which are placed in thirty-eight genera. In the present state of our knowledge the subfamily is represented in Iowa by thirty-five forms which are disposed in twenty genera.

Practically all the members of the group are plant feeders in both nymphal and imaginal stages and, as a consequence, some of the species are of considerable economic importance particularly in the South. In Iowa, however, no species of the subfamily is ordinarily present in sufficient abundance in any locality to cause material damage. A few species are, in part, predaceous in feeding habits. The differential characters of the subfamily include the following:

Bucculae long, parallel. Basal segment of rostrum usually slender and largely embedded between bucculae but extending beyond their apices; rostrum inserted a little behind tip of tylus. Pronotum without teeth or with numerous teeth near antero-lateral angles. Scutellum not exceeding corium in length and more or less narrowed at apex. Frena usually more than one-third the length of the scutellum.

Key to the tribes

Body very long, linear; second antennal segment dilated on inner side; sides of base of venter with a finely striated stridulating areaMECIDIINI

Body more or less ovate, not extremely elongate and linear; second antennal segment not dilated on inner side; venter without striated stridulating spot at sides of base

Abdomen with a shallow, longitudinal ventral sulcus; rostrum extending behind posterior coxae; juga with a prominent lateral tooth near apex.....HALYINI

Abdomen without longitudinal ventral sulcus; rostrum averaging shorter; juga without lateral tooth. PENTATOMINI

Tribe MECIDINI (Distant)

Sides of abdomen anteriorly with a transversely placed strigose stridulating spot.

This is a small tribe of about fifty species which is best represented in the Australian region. A single genus and species is recorded from North America.

Genus MECIDEA Dallas

1851. MECIDEA Dallas, List Hem., I, 131 and 139.

This peculiar genus containing only six forms has one representative in North America and it has also been recorded for Iowa. The other members of the genus are divided among the Oriental, Ethiopian and Palaearctic regions. The characters of the genus may be thus summarized:

Body elongate linear. Head somewhat pointed anteriorly, the juga longer than the tylus, meeting or almost meeting in front of it but with the tips somewhat divergent. Eyes large, globose. Antennae of five segments; second antennal segment as long as or longer than the others, expanded on inner side. Rostrum reaching hind coxae; second segment longest, as long as the two apical segments together. Scutellum triangular, very long, narrow and acute.

Mecidea longula Stål (PLATE V, FIGURE 9)

1854. *Mecidea longula* Stål, OEfv. Vet. Akad. Förh., XI, 233.

1856. *Mecidea longula* Stål, *op. cit.*, XIII, 57.

1876. *Mecidea longula* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 283.

1897. *Mecidea longula* Osborn, Proc. Ia. Acad. Sci., V, 232.

1904. *Mecidea longula* Van Duzee, Trans. Am. Ent. Soc., XXX, 26.

General form very long, linear. Color pale yellow, thickly, rather uniformly punctured with fuscous; a uniform, narrow fuscous line extending backwards on either side of the ventral aspect of the body from the base of antennae to near posterior margin of last complete abdominal segment. Head very long, narrow, pointed anteriorly; juga pale yellow, punctured with reddish brown, surpassing tylus in front of which they are contiguous with the apices slightly divergent; tylus pale yellow, the slightly impressed line on either side fuscous and more finely punctured; the pale yellow of the tylus and juga is carried posteriorly across the pronotum in three diverging rays and the median line is continued to the tip of the scutellum as a pale calloused ruga. Eyes prominent. Ocelli large, a little in front of the posterior margin of the eyes. Rostrum slender, reaching beyond midcoxae. Antennae fuscous, heavily punctured, tapering towards tip; second segment longest, expanded on inner side so that it appears triangular in outline. Side pieces of thorax irregularly, deeply punctured.

Pronotum thickly, uniformly punctured, the three pale lines which are continuous with those of tylus and juga diverging from before backwards; antero-lateral margins smooth, somewhat sinuate; humeral angles rounded, not prominent; callosities pale yellow, distinct, sometimes enclosing a small punctured area. Scutellum long, narrow, the punctures gradually diminishing in size from base to apex which is very sharp and slightly depressed; a median, longitudinal, smooth, pale calloused ruga extends from base to apex. Hemelytra pale yellow, uniformly punctured with fuscous, a little narrower than abdomen; costal margin pale clay yellow with much finer reddish or fuscous punctures; membrane hyaline, undotted. Venter pale clay yellow, smooth at the middle; at the sides the series of fuscous punctures is confined to the conspicuous longitudinal line above mentioned; a series of irregularly arranged red dots along the margin outside this line; stigmata black; an elongate and semi-transversely striate stridulating area extends on either side of the first, second and third visible ventral segments. Legs slender, pale yellow, the bases of the femora unspotted, the apical two-thirds dotted with red, the tibiae darker and more thickly dotted. Length, 11.0-13.0 mm. Width across pronotum, 3.0-3.5 mm.

The extremely slender and elongate form together with the inflated, triangular second antennal segment and the peculiar abdominal stridulatory apparatus will at once distinguish this insect from any of our other pentatomids.

Professor Osborn records a single specimen taken from the crest of a hill near Sioux City and remarks: "I know of no previous record for this species above the lower austral zone, but the Missouri valley doubtless furnishes conditions more nearly like the south and provides for the northern extension of such species" (Proc. Ia. Acad. Sci., VI, 38, 1898.) This record stands alone for the state. The type locality was Texas and the species has also been recorded from Colorado and New Mexico. My own material is all from Texas.

Tribe HALYINI (Stål)

This tribe, comprising about 225 forms, is best represented in the Australian and Ethiopian regions. Thirteen species are recorded from North America, three of which have been taken in Iowa. All belong to the genus *Brochymena*. The diagnostic characters of the tribe may be thus briefly stated:

Head elongate, the sides not distinctly sinuate in front of eyes. Antennae of from three to five segments (The North American forms all have five antennal segments); antennal tubercles visible from above. Rostrum long, slender, usually reaching abdomen. Eyes very prominent. Tibiae unarmed. Abdomen with a more or less distinct longitudinal furrow.

Genus BROCHYMENA Amyot and Serville

1843. BROCHYMENA Amyot and Serville, Hém., 106.

Typically, this is a Nearctic genus but it has extended its range into the Neotropical region through Mexico and as far south as Costa Rica. All the Iowa representatives of the genus may be told at sight by the roughened appearance and grayish brown color. The technical generic diagnosis will include the following characters:

Lateral margins of head unarmed; anterior border more or less distinctly emarginate; jugs with lateral tooth near apex. Antennae cylindrical, of five segments; basal segment not reaching anterior margin of head. Rostrum surpassing to a greater or lesser degree the metasternum. Prothorax with lateral margins not reflexed but more or less denticulate and with the posterior angles somewhat prominent. Scutellum more or less triangular with apex entire. Veins of membrane branching irregularly. Abdomen with a shallow longitudinal sulcus.

Stål also includes, "metastethus spiracula segmenti primi ventris tegente."

Key to the species

Humeral angles distinctly produced into a short, dentate, truncated lobe not rounded anteriorly; scutellum with a distinct transverse elevation at base.....*arborea*

Humeral angles less prominent, rounded anteriorly and armed with numerous teeth; scutellum not strongly elevated at base

Juga considerably longer than tylus, contiguous anteriorly or separated and forming a long narrow sinus; sides of pronotum with pale irregular teeth.....*quadripustulata*

Juga little longer than tylus, convergent at apex over tip of tylus forming a short, nearly transverse apical sinus; sides of pronotum strongly arcuated and furnished with close and quite regular teeth.....*carolinensis*

Brochymena arborea (Say) (PLATE VI, FIGURE 1)

1825. *Pentatoma arborea* Say, Journ. Acad. Nat. Sci. Phila., IV, 311.

1840. †*Halys erosa* Herrich-Schaeffer, Wanz. Ins., I, 188.

1840. †*Halys erosa* Herrich-Schaeffer, Wanz. Ins., V, 70, fig. 515.

1851. *Brochymena arborea* Dallas, List Hem., I, 188.

1859. *Pentatoma arborea* Say, Compl. Writ., II, 239.

1876. *Brochymena arborea* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 283.

1880. *Brochymena arborea* Distant, B. C. A. Rhynch. Het., I, 52.

1904. *Brochymena arborea* Van Duzee, Trans. Am. Ent. Soc., XXX, 27.

1909. *Brochymena arborea* Kirkaldy, Cat. Hem. (Heterop.), I, 191.

Body broadly ovate, the abdomen extending laterally considerably beyond hemelytra. General color brownish gray, thickly, irregularly punctate.

tured with black. Head long, with a median, slightly raised line contiguous with the somewhat elevated juga and reaching to the posterior border; a shorter, somewhat elevated line on either side of this; juga slightly longer than tylus, the apex narrow; subapical tooth large, obtuse, almost attaining anterior margin of head. Antennae black with narrow basal portions of segments one, two, three and four pale. Rostrum long, slender, extending on to third visible ventral segment; pale, with apex of second segment and entire apical segment fuscous. Pronotum much more coarsely punctured on basal than anterior part; antero-lateral margins usually armed with four or five irregular, unequal, acute teeth; posterior angles extending in short, prominent, subtruncate processes, somewhat dilated and bearing two or three small teeth. Scutellum coarsely punctured, the coarse punctures more freely interspersed with finer ones near the top which is bluntly rounded and more or less distinctly impressed on the middle; immediately anterior to this depression the median longitudinal area is raised into a more or less distinct carina which extends forward to the base; basal portion of scutellum distinctly raised and somewhat rugose. Hemelytra rather finely punctate; nervures of the whitish membranous portion black and with black arborescent lines between. Mesosternum with an irregularly transverse black area at middle. Venter broad, yellowish gray to brownish, covered more or less regularly with short grayish pubescence; irregularly, sparsely punctate with brown on middle, more densely and finely punctate at sides. Stigmata black; just posterior to each opening is an oval, depressed, finely punctate, black area which is continued for about one-third the distance towards the median line as a narrow groove bearing fine punctures and showing distinctly as a dark line. Femora dark brown, pale at base, more or less distinctly annulate with pale near tips; tibiae also annulate with pale; a pale spot on outer side of first and third tarsal segments, the second segment entirely pale. Length, 13.5-17.0 mm. Width across pronotum, 8.0-9.0 mm.

Although subject to some variation in the form of the apex of the head, the punctuation of the scutellum and the armature at the sides of the pronotum, the present form usually may be recognized from our other two representatives of the genus by the fact that the lateral thoracic angles extend in short, subtruncate processes which are produced into a distinct tooth, and the apical portion of the scutellum is proportionately more narrowed and impressed on the median line; in addition, the juga are usually a little longer than the tylus and the subapical tooth is large, almost reaching the tip of the head.

Brochymena arborea is widely distributed over the United States and Canada and extends southwest into Mexico. In Iowa it is not as abundant as *B. quadripustulata*. Five speci-

mens, two males and three females, are at hand from Iowa City and Robinson. One of the Iowa City specimens was found dead on a small board floating in the Iowa river March 29. A half grown nymph from Robinson was collected on wild crab apple, August 25. Another nymph of about the same size which is in my collection was taken at Connersville, Indiana, in July. My latest seasonal record for Iowa is October 31. The species was recorded from Iowa by Osborn.

Brochymena quadripustulata (Fabricius) (PLATE II, FIGURE 10, and PLATE VI, FIGURE 3)

- 1775. *Cimex 4-pustulatus* Fabricius, Syst. Ent., 704.
- 1803. *Halys 4-pustulata* Fabricius, Syst. Rhyng., 182.
- 1805. †*Halys serrata* Pal. Beauv., Ins. Afr. Amér., 187, Hem. Pl. 11, fig. 8.
- 1839. *Halys pupillata* Herrich-Schaeffer, Wanz. Ins., IV, 104, fig. 453.
- 1843. *Brochymena serrata* Amyot and Serville, Hém., 107.
- 1872. *Brochymena quadripustulata* Stål, Svensk. Vet. Handl., 10, no. 4, 16.
- 1874. *Brochymena 4-punctata* Prov., Nat. Can., 74.
- 1876. †*Brochymena annulata* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 283.
- 1880. *Brochymena quadripustulata* Distant, B. C. A. Rynch. Het., I, 51.
- 1904. *Brochymena quadripustulata* Van Duzee, Trans. Am. Ent. Soc., XXX, 28.
- 1915. *Brochymena quadripustulata* Stoner, Ent. News, XXVI, 355.

Body elongate ovate, not so broad as *B. arborea*. General color brown, closely, irregularly punctured with black, the areas between the punctures yellowish to yellowish white; maculated calluses of pronotum and scutellum more or less distinct. Head long, narrow, more narrowly and deeply cleft at apex than in *B. carolinensis*; juga more or less rounded at apex, sometimes contiguous before the apex. Rostrum shorter, not extending on to third visible ventral segment. Antennae fuscous, the pale color at the incisures not distinct; second segment usually shorter than or equal to the third. Pronotum punctured to margins which are furnished with pale irregular teeth anterior to the sinus; humeri not much elevated, the anterior margins with a few small teeth; posterior submargin of pronotum narrowly impressed. Scutellum almost uniformly coarsely punctate, the apex a little more finely punctate, somewhat depressed; median longitudinal carina not prominent. Hemelytra rather coarsely punctate leaving irregular raised maculations on the surface. Venter reddish brown, darker at sides and paler on median line; finely, irregularly punctate with dark brown or black. A pale band on middle of connexivum of each segment. In the female, the last complete ventral segment and the genital plate each bears a black spot. Behind each spiracle is a finely punctured depressed black area which is continued inward as a black impressed line. Mesosternum marked with black. Ostiolar canal tipped with black and on the pro- and mesosternum opposite the front and middle coxae is a small black depression. Legs irregularly maculated with yellowish and blackish; posterior tibiae broadly annulate with yellowish marked above

by a black spot thus giving the appearance of bimaculation. Length, 8.0 mm. (male)-17.0 mm. (female). Width across pronotum, 6.0 mm. (male)-9.0 mm. (female).

This is our commonest species of *Brochymena* and, like our other forms, displays considerable variation. In general, however, certain characters hold very well and Van Duzee (*l. c.*) has pointed out those of distinctive value as follows: "The long head, narrow and cleft at apex, the rounded anterior margin of the humeri, and the pale irregular teeth on the sides of the pronotum anteriorly will distinguish this species."

B. quadripustulata extends practically throughout the United States and Canada and is probably the most common species of the genus. Sixteen Iowa specimens are at hand from Ames, Iowa City and Lake Okoboji only. A number of specimens have been taken from willows growing in moist situations. At Lake Okoboji two nymphs were taken on July 4 under such conditions and at Iowa City on August 20 two nearly mature insects and one adult were collected under similar circumstances.

On November 13, four adult specimens were taken from under dead leaves along the border of a sand area near the Iowa river. While examining one of these specimens, after having picked it from under the leaves, it ejected with considerable force and to a distance of at least six inches, a drop of fluid from the ostiolar orifice. The morning was quite cool since a heavy frost had occurred during the night and, although the insect was practically unable to move, the scent glands seemed to be in good working order.

My earliest seasonal record for the species is March 24 when a specimen was found hibernating in a dead stump. On April 6 a specimen was found under dry oak leaves.

Although this form was not recorded from Iowa by Osborn, it is possible that the form which he determined as *B. annulata* is the one here discussed.

Brochymena carolinensis (Westwood) (PLATE VI, FIGURE 2)

- 1775. ||*Cimex annulatus* Fabricius, Syst. Ent., 704.
- 1803. ||*Halys annulata* Fabricius, Syst. Rhyng., 182.
- 1811. †*Halys serrata* Wolff, Ic. Cim., V, 184, fig. 178.
- 1837. *Halys carolinensis* Westwood, Cat. Hope, I, 22.
- 1871. *Brochymena harrisii* Uhler, Proc. Bost. Soc. Nat. Hist., XIV, 95.
- 1872. *Brochymena carolinensis* Stål, Svensk. Vet. Handl., 10, no. 4, 17.
- 1872. ||*Brochymena annulata* Stål, Svensk. Vet. Handl., 10, no. 4, 16.

1900. *Brochymena carolinensis* Distant, Proc. Zool. Soc. London, 823.

1904. *Brochymena annulata* Van Duzee, Trans. Am. Ent. Soc., XXX, 30.

1909. *Brochymena carolinensis* Kirkaldy, Cat. Hem. (Heterop.), I, 191.

Body more broadly ovate than *B. quadripustulata*. General color brown, the surface more finely and closely punctured than in that species and marked in places with irregular groups of large black punctures. Head elongate but broader and shorter than in *B. quadripustulata* with the tylus a little shorter than juga thus leaving the apical sinus nearly transverse; juga more or less acute at apex; lateral projections short. Rostrum long, extending on to third ventral segment. Antennae fuscous, pale at the joints; second segment distinctly shorter than third. Pronotum punctured to lateral margins which are distinctly rounded anterior to the sinus and bear regular, closely set teeth; humeri rounded and elevated above, the anterior margins with a few small teeth; posterior submargin of pronotum more broadly and deeply impressed than in *B. quadripustulata*. Scutellum broader, longer and more finely punctate than in that species, the punctures near the anterior basal angles fine and closely aggregated; apex more finely punctate, somewhat depressed. Hemelytra rather finely punctate with usually a small pale spot on the posterior part of the disk. Venter reddish brown to black, darker at sides, paler on impressed median line; a pale band on middle of connexivum of each segment. Genital plate and last complete ventral segment in the female without black spot. Mesosternum marked with black. Ostiolar canal and depression on side pieces of pro- and mesothorax similar to *B. quadripustulata*. Legs black with irregular yellowish maculations and long white hairs; posterior tibiae with a broad, complete annulus which may have a black spot above. Length, 8.0 mm. (male)-18.0 mm. (female). Width across pronotum, 7.0 mm. (male)-10.0 mm. (female).

The differences between this and the preceding species I have attempted to set forth in the descriptions so that they need not be repeated here. However, it should be borne in mind that considerable variation obtains in both species. These variations affect some of the differential characters mentioned in the diagnoses which, however, are based as nearly as possible upon typical specimens. Some of the variations may be briefly mentioned: The second and third antennal segments are somewhat variable in length. Uhler says of this feature (U. S. Geol. Surv. Mont., V, 394, 1872): "Usually these two joints are about equal in length, but sometimes the second is very little more than one-half the length of the third; specimens have occurred to me in which these joints have been equal in the one antenna." In some specimens of *B. carolinensis* the tips of the juga converge anteriorly over the tylus. Usually the connexi-

vum is strongly banded with yellowish, the black being confined to the incisures; some specimens have the entire margin of the connexivum pale. The punctuation varies also in different specimens but, in general, it is ordinarily finer than in *B. quadripustulata* thus leaving the yellowish rugae between less prominent than in that species.

I have been unable to place any of my Iowa specimens of *Brochymena* in this species. Professor Osborn listed it as common in Iowa (Proc. Ia. Acad. Sci., I, Pt. II, 121, 1892), but I am inclined to think that the species to which he there refers is *B. quadripustulata*. *B. carolinensis* seems to be comparatively rare and confined to eastern and southeastern United States. Van Duzee says, "It is more abundant toward the south, my material showing a range from southern New York to Florida." (l. c. 31). Alabama and Florida specimens are in my collection.

Tribe PENTATOMINI (Stål)

This is the largest tribe in the family Pentatomidae and contains in the neighborhood of 1,500 forms, approximately 400 of which are found in America. North America is represented by about 125 forms disposed in 33 genera; of these, 31 forms placed in 18 genera are recorded from Iowa. The principal characters of the group follow:

Body more or less ovate. Head usually only slightly convex on dorsal surface; juga without lateral tooth and usually not longer than tylus. Abdomen without longitudinal ventral sulcus. Scutellum generally moderate but extending much beyond frena. Tarsi of three segments (except in one Oriental genus in which there are two segments).

Key to the genera

1. Second visible ventral segment of abdomen armed with a median spine or obtuse tubercle directed anteriorly....16
Second visible ventral segment of abdomen unarmed.... 2
2. Odoriferous orifices a little outside lateral margins of middle coxal cavities; not elevated or continued in a sulcus; lateral margins of juga reflexed and much thickened; head strongly deflexed, front nearly vertical....*Murgantia* (15)
Odoriferous orifices far outside lateral margins of middle coxal cavities or elevated or continued in a sulcus; lateral

- margins of juga not or only slightly reflexed, not much thickened; head usually not strongly deflexed.....3
3. Scutellum broad and rounded at apex, the lateral margins almost straight; head bent strongly downwards
Cosmopepla (11)
- Scutellum usually distinctly narrowed at apex, the lateral margins concave; head not or only slightly deflexed.....4
4. Odoriferous orifices elevated, with a sulcus continued laterally in a gradually disappearing wrinkle.....5
Odoriferous orifices not elevated, the sulcus absent or ending abruptly and not continued laterally in a gradually disappearing wrinkle6
5. Juga not longer than tylus.....*Thyanta* (14)
Juga longer than tylus and almost or quite contiguous anteriorly*Peribalus* (1)
6. Veins of membrane irregularly anastomosing or with more or less distinct branches.....7
Veins of membrane simple or but slightly branched.....9
7. Scutellum broadly rounded at apex, as long as or nearly as long as corium which has the apical margin rounded and the apical angle obtuse.....*Coenus* (8)
Scutellum narrowed at apex, shorter than corium which has the apical margin straight or sinuate and the apical angle acute8
8. Bucculae gradually increasing in height posteriorly, ending abruptly; frena extending just to middle of scutellum; lateral pronotal margins not explanate; rostrum extending a little behind midcoxae*Hymenarcys* (9)
Bucculae decreasing in height posteriorly, elevated into an angle anteriorly; frena extending beyond middle of scutellum; lateral pronotal margins explanate anteriorly; rostrum extending behind postcoxae.....*Menecles* (12)
9. Frena not extending beyond middle of scutellum.....10
Frena extending beyond middle of scutellum.....12
10. Lateral pronotal margins with a prominent process bent slightly backwards at humeral angles.....*Prionosoma* (13)
Lateral pronotal margins entire, the humeral angles rounded and not prominent.....11

11. Jugal longer than tylus and contiguous or nearly so anteriorly; head very convex on dorsal surface; apex of corium broadly rounded*Neottiglossa* (10)
 Jugal not or scarcely longer than tylus, not approaching anteriorly; head only slightly convex on dorsal surface; apex of corium with a distinct angle.....*Trichopepla* (2)
12. Tibiae plainly sulcate above for their entire length.....13
 Tibiae nearly or quite cylindrical.....15
13. Lateral margins of pronotum crenulate; lateral angles prominently rounded or pointed; head elongate

Euschistus (7)

 Lateral margins of pronotum entire; lateral angles rounded but not prominent; head, including eyes, wider than long14
14. Form elongate; olive green in color; second and third segments of rostrum of about equal length, the fourth shorter.....*Rhytidolomia* (3)
 Form broader; clear green in color; second segment of rostrum longer than third, the latter equal to the fourth*Chlorochroa* (4)
15. Thorax unarmed; basal segment of rostrum longer than bucculae; form broad*Mormidea* (5)
 Thorax armed with a long, sharp anteriorly projecting spine at lateral angles; basal segment of rostrum shorter than bucculae; form long, narrow.....*Solubea* (6)
16. Jugal longer than tylus, contiguous or almost contiguous anteriorly; general color ochraceous; smaller in size

Dendrocoris (18)

 Jugal sometimes a little longer than tylus but not contiguous anteriorly; general color some shade of green; averaging larger in size.....17
17. Fifth segment of antennae more than twice as long as second; greenish or olive greenish in color with apex of scutellum and anterior half of pronotum lighter..*Banasa* (17)
 Fifth segment of antennae less than twice as long as second; clear green in color with apex of scutellum and anterior half of pronotum concolorous.....*Acrosternum* (16)

Genus PERIBALUS Mulsant and Rey

1866. PERIBALUS Mulsant and Rey, Punaises de France, Pent., 237, 262.

1909. †HOLCOSTETHUS Kirkaldy, Cat. Hem. (Heterop.), I, 47.

The nearly twenty representatives of this genus are confined to the Palaearctic and American regions. Three representatives have been recorded from Iowa.

Body not pilose above. Head broad, rounded in front, the juga without lateral tooth, longer than tylus and contiguous or almost contiguous at anterior extremity; sides of head moderately sinuate in front of eyes. Humeri rounded, not prominent. Apex of scutellum distinctly narrowed. Ostiolar orifice prolonged into a sulcus which gradually becomes evanescent. Base of abdomen unarmed. Tibiae sulcate above.

Key to the species

Connexivum alternated; head longer and broader.. *abbreviatus*
Connexivum black with a pale margin; head shorter and narrower

Body more depressed, gradually narrowed posteriorly; general color lighter..... *limbolarius*

Body strongly convex, broader behind middle; scutellum broad at tip; general color darker..... *piceus*

Peribalus abbreviatus (Uhler)

1872. *Holcostethus abbreviatus* Uhler, Rept. U. S. Geol. Surv., V, 397.

1877. *Holcostethus abbreviatus* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 403.

1904. *Peribalus abbreviatus* Van Duzee, Trans. Am. Ent. Soc., XXX, 33.

1909. *Holcostethus abbreviatus* Kirkaldy, Cat. Hem. (Heterop.), I, 47.

General form subdepressed, oval. Color grayish to reddish brown spotted with black. Rugulose and irregularly punctured with black. Head long, broad, widely rounded in front, closely punctured with black, the punctures on the tylus and along sides of head confluent; juga flattened, longer than tylus and meeting or almost meeting in front of it; margins of head rather distinctly sinuate in front of eyes; head beneath pale yellowish, coarsely punctured, a few coarse punctures in front of eye black or blackish. Antennae long, slender, pale yellow to rufous, the basal segment very short, pale; second and third longer, subequal; fourth and fifth still longer and subequal. Rostrum pale yellowish, extending to first visible ventral segment; tip and median line blackish. Pronotum short, broad; posterior half rather sparsely, irregularly punctate with smooth calluses between the punctures; anterior half more finely, densely punctured, the punctuation of the lateral submargins very dense; lateral margins yellowish or reddish yellow, arcuate, a little thickened and elevated, smooth and impunctate; humeri more prominent and broadly rounded than in *P. limbolarius*. Scutellum rather finely, closely punctured

with black except at tip which is white and broadly rounded; a more or less distinct transverse depression near middle; base more finely punctate and usually with an impunctate whitish callus at each angle and on the median line. Hemelytra sparsely, irregularly punctate, often more or less reticulately punctured; embolium punctured entirely to costal margin which is not distinctly paler; membrane pale brown with five or six nervures. Venter yellowish, the disk smooth, the sides minutely wrinkled, the reddish and black punctures closer on the sides; three series of more or less distinct blackish punctures on each side; an aggregation of fine black punctures at the outer angle of each incisure. Tergum black. Connexivum yellow with two black spots at the ends of the incisures. Ventral plates of thorax yellowish, coarsely, irregularly punctured with reddish brown; from one to three black dots on each side of the three principal sternal plates including one at the ostiolar opening. Legs yellowish, the femora minutely, rather closely punctured with brownish or blackish; tibiae finely punctured with brownish, darker towards tip; tarsi rufous to reddish brown, the claws black at tip. Length, 8.0-10.0 mm. Width across pronotum, 5.0-6.0 mm.

This is typically a western form more or less characteristic of the Rocky Mountain region and but a single Iowa record is available. Osborn records one specimen from Ames. (Proc. Ia. Acad. Sci., V, 232, 1897). Zimmer reports the species from Nebraska and adds, "Not common but found in the northern and western parts of the state." (Contrib. Dept. Zool. No. 4, Univ. Neb., 6, 1911). It has also been recorded from Kansas, Colorado, Montana, Utah, Lower California and British America. In addition my own collection contains specimens from Oregon, Washington and New Mexico.

Peribalus limbolarius Stål

- 1872. *Peribalus limbolarius* Stål, Svensk. Vet. Handl., 10, no. 4, 34.
- 1872. *Peribalus modestus* Uhler, Rept. U. S. Geol. Surv., V, Pt. 4, 396.
- 1876. *Peribalus modestus* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 289.
- 1877. *Peribalus limbolarius* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 403.
- 1880. *Peribalus limbolarius* Distant, B. C. A. Rhynch. Het., I, 65, Pl. 6, fig. 19.
- 1904. *Peribalus limbolarius* Van Duzee, Trans. A'm. Ent. Soc., XXX, 32.
- 1909. *Holcostethus limbolarius* Kirkaldy, Cat. Hem. (Heterop.), I, 48.

General form subdepressed, ovate, narrowed more posteriorly than *P. abbreviatus*. Color grayish or reddish yellow punctured with black, the black punctures assuming a more or less reticulate pattern on hemelytra and scutellum. Head finely punctured with black the punctures denser and finer at the sides before the eyes; a short, impunctate, yellowish line on tylus between eyes; juga much longer than tylus, usually meeting in front but sometimes not in contact at tips; margins of head a little reflexed, not so distinctly sinuate in front of eyes as in *P. abbreviatus*; head beneath pale yellow, irregularly punctured, a few blackish punctures

before the eye. Antennae rufous to reddish brown, the basal segment pale yellowish, very short; second and third longer, slender, subequal, fourth black except base and tip, fifth longest, blackish except base. Rostrum, except tip and median line pale yellowish, extending to mid-coxae; second segment longest, fourth segment shortest. Pronotum short, broad, irregularly, coarsely punctured on posterior half, more finely and regularly punctured anteriorly, the black punctures along the lateral submargin aggregated to form a line there; lateral margins yellowish or yellowish white, straight, thickened, elevated, smooth, impunctate; humeri rounded not prominent. Scutellum more finely punctate than pronotum, the punctures at base fine and close, the apical half, except tip, more or less rugulose; smooth calluses at base varying from one at each angle to almost a complete transverse line; apex smooth, white. Hemelytra rather more finely and irregularly but less densely punctate than scutellum, the surface often showing the punctures arranged in a reticulate pattern; embolium yellowish white, the costal margin impunctate; membrane pale brownish with six or seven darker veins. Venter pale yellow, the disk almost smooth, the sides finely, transversely rugulose and sparsely punctate; general punctuation usually reddish, the larger punctures black and arranged in three sinuous series on each side; a group of small black punctures before and behind the outer angle of each incisure. Tergum and connexivum black, the latter with a yellowish margin the inner edge of which is more or less distinctly scalloped. Ventral plates of thorax pale yellow, irregularly, coarsely punctured; a black dot on each of the three principal sternal plates. Legs pale yellow, the femora with irregularly disposed black punctures, those near the tip larger; tibiae with small brown punctures; tarsi reddish brown, the claws black at tip. Length, 7.5-9.5 mm. Width across pronotum, 5.0-6.0 mm.

The characters mentioned in the key along with the above diagnosis of this well known pentatomid should serve sufficiently for its ready delimitation from our other two Iowa representatives of the genus both of which are very rare in the state.

Considerable variation in color and size is found in the present species. Specimens from western United States are likely to be smaller and paler than those from the eastern states, while in Iowa both the pale and rather dark specimens are found in about equal numbers. The reticulate pattern may be very distinct or may not be at all apparent. The amount of black on the fourth and fifth antennal segments may vary. The membrane may vary from deep bronze to hyaline and the connexivum may be more or less indented within thus approaching *P. abbreviatus* in which the connexivum is alternated. The genital segment of the male is emarginate at the middle and distinctly

sinuate on either side; in addition, the fine punctures on the venter of the male are reddish while the larger ones are black.

This species along with *Euschistus variolarius* shares the distinction of being the most common and widely distributed representative of the Iowa Scutelleroidea. Many specimens are at hand from more than forty localities in the state and a complete list of locality records would include practically every place in which collecting has been done. However, in northwestern Iowa, particularly in the vicinity of Lake Okoboji, the number of specimens taken has been surprisingly small. Osborn reported the species as common in Iowa.

Apparently this is a very hardy and prolific insect. My records show that specimens have been taken in every month of the year except December and January, the earliest spring record being February 28 and the latest autumn record November 6. Hibernating individuals are usually found under sticks, boards and stones in meadows and pastures or in out of the way places such as roadsides and fence corners which have been allowed to grow up in clover or weeds. Often, too, specimens are found beneath a heavy fall of leaves along the edges of woods. Nymphs have been found in the months of June, July, August and September. Half grown nymphs have been taken June 26, while nymphs less than half grown have been collected as late as September 25. In general, the nymphs seem to be most abundant in July and August and the available records and data show that at least two generations and possibly a partial third generation develop annually in the field in Iowa. Individuals in copula have been swept from vegetation usually between June 30 and July 16.

One of the commonest food plants is *Solidago* sp. upon which the insects may often be captured in large numbers. During the summer patches of sweet clover growing along roads and edges of fields are frequently quite heavily infested by this bug. Red clover and timothy fields seem also to be favorite haunts and I have found that dry situations seem to be preferred to moist ones. This insect has also been collected on wild grape (*Vitis vulpina* Linn.), ragweed (*Ambrosia artemisiifolia* Linn.) and mullein (*Verbascum thapsus* Linn.). The latter plant

seems to be a favorite resort of this as well as of some other species of the tribe as the cool autumn days approach for the soft downy leaves afford considerable warmth. In the spring or late fall it is no uncommon thing to find the remains of several of these pentatomids around the larger plants, mute testimony of the inability of any considerable number of the insects to find there sufficient shelter to weather the cold winter successfully. On October 3, 1913, I swept great numbers of this species from turnips growing in a small truck patch near Iowa City.

Peribalus piceus (Dallas)

1851. *Pentatoma picea* Dallas, List Hem., I, 236.

1904. *Peribalus piceus* Van Duzee, Trans. Am. Ent. Soc., XXX, 34.

1909. *Holcostethus piceus* Kirkaldy, Cat. Hem. (Heterop.), I, 48.

General form more convex both above and below than either of the preceding species; broadest behind middle. Color darker, the pale margin of pronotum, abdomen and tip of scutellum strongly contrasted. Body more or less densely clothed with short, stiff hairs which are most conspicuous on edges of head and pronotum. Head more deeply, coarsely and uniformly punctured than in our other forms. Scutellum broad, irregularly, coarsely punctate at base, more uniformly punctate at middle.

In addition, this species differs from our other representatives of the genus as follows: "There is a pair of round white dots on the disk of the pronotum anteriorly, and the pale margin of the connexivum is undulated within; the legs are piceous, becoming pale brown on the outer surface of the tibiae and base of the tarsi; antennae brown, shading to piceous on the apical joints and with the incisures pale; rostrum brown, reaching the posterior coxae." (Van Duzee, *l. c.*)

This insect seems to be rather rare although it apparently enjoys a wide range in our northern states and Canada. It has been recorded from Montana and Ottawa, Ontario, and the type was from Hudson Bay. Osborn records two specimens from Little Rock, Iowa, which were collected by E. D. Ball. (Proc. Ia. Acad. Sci., V, 232, 1897.) Other Iowa specimens have not come to light. The only specimen in my collection is labelled "N. Illinois," and thus furnishes a further distributional record for the species.

Genus TRICHOPEPLA Stål

1867. TRICHOPEPLA Stål, Cefv. Vet. Ak. Förh., XXIV, 528.

Seven species are described in the genus; all are found in the New World, six in North America and one in Central America. Two of the North American representatives have been recorded from Iowa. The others which have recently been described by Van Duzee are from California and Idaho. Diagnostic characters of the genus follow:

Body pilose, dorsal surface with coarse black punctures more or less irregularly disposed. Sides of head nearly straight, slightly sinuate in front of eyes. Jugal rounded at apex, not longer than tylus. Rostrum extending to posterior coxae. Antennae short, first segment not reaching apex of head. Pronotum convex, deflexed anteriorly; lateral margins entire, slightly reflexed; lateral angles rounded. Apex of corium with a distinct but somewhat rounded lateral angle; veins of membrane simple. Ostiolar canal continued into a sulcus which ends abruptly.

Key to the species

Antennae rufous, two apical segments only black; head narrowed at apex; rostrum at least attaining apex of posterior coxae; pronotum shorter, the sides oblique.....*semivittata*
Antennae black, first segment only rufous; head broader at apex; rostrum not surpassing base of posterior coxae; pronotum longer, the sides less oblique.....*atricornis*

Trichopepla semivittata (Say) (PLATE V, FIGURE 7)

1831. *Pentatoma semivittata* Say, Descr. Het. Hem., 9.

1844. *¶Pentatoma semivittatum* Herrich-Schaeffer, Wanz. Ins., VII, 101, fig. 766.

1851. *¶Pentatoma pilipes* Dallas, List Hem., I, 247.

1859. *Pentatoma semivittata* Say, Compl. Writ., I, 322.

1872. *Trichopepla semivittata* Stål, Svensk. Vet. Handl., 10, no. 4, 34.

1876. *Trichopepla semivittata* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 289.

1880. *Trichopepla semivittata* Distant, B. C. A. Rhynch. Het., I, 64, Pl. 6, fig. 15.

1904. *Trichopepla semivittata* Van Duzee, Trans. Am. Ent. Soc., XXX, 34.

General form ovate, broadest behind the middle, more or less pointed anteriorly. General color pale clay yellow with numerous large black punctures and with numerous fine, short, erect, yellowish white hairs most abundant on head and prothorax. Head elongate, densely punctured, black with a median and two lateral pale vittae which are sparsely or not at all punctured; apex slightly emarginate the median lobe higher than lateral lobes, its apex more or less reddish; lateral margins black, densely punctate. Rostrum pale with median line and apical segment black. Antennae with the three basal segments yellowish to rufous with the two apical segments black. Pronotum closely, strongly punctate anteriorly, the punctures on disk and posterior part more sparse and irregularly placed; three pale vittae continuous with those on the head become obsolete pos-

teriorly; lateral margins impunctate, the edges slightly arcuate; lateral angles rounded, not prominent. Scutellum with five pale impunctate vittae becoming confluent on posterior half; punctuation sparse at base, finer and more regular towards apex. Coriaceous portion of hemelytra thickly, finely punctured with black, the costal margin and lines following the veins sometimes pale and impunctate; membrane pale brownish, semi-transparent. Tergum black, the connexivum pale but alternated with black at the incisures. Venter pale clay yellow, thickly, finely punctate; a more or less interrupted lateral vitta of black punctures extends from behind the eyes nearly to tip of abdomen. Ventral plates of prothorax pale yellow, coarsely, irregularly punctured with black. Legs pale yellow, thickly clothed with short fine hairs; femora with a more or less complete brownish annulus near tip; tibiae darker towards apex; tarsi brownish, the apical segment and claws black. Length, 5.5-9.0 mm. Width across pronotum, 3.5-5.0 mm.

This insect is subject to the ordinary amount of variation in size, punctuation and color but may at once be distinguished from the other Iowa representative of the genus by the characters mentioned in the key and the description. It is widely distributed but in Iowa it is not common anywhere. Only six specimens are at hand from Boone, Ft. Madison and Red Oak. This species was erroneously listed from the Lake Okoboji region (Stoner, The Pentatomoidea of the Lake Okoboji Region, Bull. Lab. Nat. Hist. S. U. I., VII, No. 3, 44, 1917) but that citation should have been for the other Iowa representative of the genus, *T. atricornis*. Osborn recorded *T. semi-vittata* as not common in Iowa.

At Ft. Madison on June 30 specimens were swept from rank weeds growing in a small uncultivated area situated between a wooded plot and a grain field. On July 4 a single specimen was taken from wild carrot (*Daucus carota* Linn.) near Boone. "I once found this insect in large numbers on carrot blossoms in a waste field near Buffalo as late as November 3d. They were in all stages of development, and I was surprised to find that the imagoes were blackish at first with the connexivum margined with pale. After they attained full maturity they assumed their ordinary pale color, with the connexivum maculated." (Van Duzee, l. c.) Blatchley (Can. Ent., XXVIII, 266, 1896) records the species from Vigo county, Indiana, and states that on September 9, 1894, it was "common in all stages, on the heads, and in the angles of the leaves, of the plant known as Rattle-

snake-Master, or Button Snake-root (*Eryngium yuccaefolium* Michx.)." I have not taken nymphs of this bug in Iowa.

Trichopepla atricornis Stål

1872. *Trichopepla atricornis* Stål, Svensk. Vet. Handl., 10, no. 4, 34.

1904. *Trichopepla atricornis* Van Duzee, Trans. Am. Ent. Soc., XXX, 35.

1909. *Trichopepla atricornis* Kirkaldy, Cat. Hem. (Heterop.), I, 49.

Closely allied to *T. semivittata* and resembling that species in general but differing from it in the following characters: General form averaging slightly wider. Head broader, more distinctly sinuate in front of eyes. Antennae entirely black, the tubercles only pale. Pronotum proportionately longer and the lateral margins less oblique. Adults with connexivum black, the margin sometimes entirely pale and scalloped within; in some specimens the connexivum is alternated as in *T. semivittata*. Membrane of hemelytra averaging darker than in that species. Tarsi black. Length, 7.0-9.5 mm. Width across pronotum, 4.0-5.25 mm.

In addition to the above, my specimens of this form average darker and more pilose than the preceding species and the rostrum is also shorter than in *T. semivittata*.

Trichopepla atricornis seems to be even less common than its congener and but four specimens are in my collection from Iowa City and Lake Okoboji. The two Iowa City specimens were taken on July 9 from wild carrot (*Daucus carota* Linn.) growing in a vacant lot within the city limits. One of the Lake Okoboji specimens was taken on low grass near Hayward's Bay, July 8. Osborn recorded the species from Little Rock and Ames. In its general distribution it is more characteristic of the northern and western states than is the preceding species.

Genus RHYTIDOLOMIA Stål

1872. RHYTIDOLOMIA Stål, Svensk. Vet. Handl., 10, no. 4, 33.

This and the following genus are very closely allied and both have, at one time and another been given subgeneric rank under the generic name *Lioderma* erected by Uhler. Both genera have also been included by many authors under the name *Pentatoma* in which case *Lioderma* has been accorded subgeneric rank along with *Rhytidolomia* and *Chlorochroa*. However, the *Lioderma* of Uhler has been found to be preoccupied so that, the subgenera *Rhytidolomia* and *Chlorochroa* of Stål having been raised to generic rank, they become available for receiving these Scutelleroidea.

General form elongate, distinctly produced anteriorly. Color olive green. Head and pronotum together forming a long triangle, the pronotum inclining slightly anteriorly. Rostrum extending behind posterior coxae, the second and third segments of about equal length, the fourth shorter than the third. Antennae long, slender, bearing at base a blunt rounded tooth which in turn bears a smaller tooth near its base. Bucculae extending almost to base of head, expanded into rounded flaps anteriorly. Humeral angles rounded, the postero-lateral margins sinuate. Scutellum long, narrow. Corium produced at outer posterior angle. Legs with long slender hairs; basal tarsal segment of front legs long and stout.

This is a small genus, representatives of which are found in the New World only. Six species are recorded from North America and one of these has been found in Iowa.

Rhytidolomia belfragii Stål

- 1872. *Lioderma* (*Rhytidolomia*) *Belfragii* Stål, Svensk. Vet. Handl., 10, no. 4, 33.
- 1876. *Lioderma belfragii* Uhler, Bull. U. S. Geol. Geogr. Surv., II, no. 5, ser. 2, 287.
- 1896. *Lioderma belfragii* Osborn, Proc. Ia. Acad. Sci., IV, 231.
- 1898. *Lioderma belfragii* Osborn, Proc. Ia. Acad. Sci., VI, 37.
- 1904. *Pentatoma Belfragei* Van Duzee, Trans. Am. Ent. Soc., XXX, 37.
- 1909. *Rhytidolomia belfragii* Kirkaldy, Cat. Hem. (Heterop.), I, 53.
- 1911. *Liodermium* (*Rhytidolomia*) *belfragii* Zimmer, Contrib. Dept. Ent. Univ. Neb., no. 4, 7.

This form differs very markedly from the following species, its nearest ally in our fauna, but it somewhat resembles *R. faceta* in its general markings. The following brief diagnosis will serve the present need.

General form broadly oval; distinctly, rather regularly punctate above and below. General color light greenish yellow, the hemelytra and venter a clearer green; narrow edge of pronotum, hemelytra and a more or less distinct median vitta on scutellum yellowish. Head short, the sides only moderately sinuate in front of the eyes. Antennae black, the basal segment green. Humeral angles obtusely rounded. Lateral border of apical portion of scutellum black. Hemelytra with costal margin beyond middle blackish; membrane dark hyaline, the interior basal angle fuscous. Dorsum of abdomen black, the last segment with two bands interrupted at middle by an olivaceous spot. Venter with punctures distinct, the median line smooth. A slender, curved, longitudinal black line on prostethus. Apex of genital segment of male slightly concave, with a rounded median tooth, the outer angles obtuse. Tibiae deeply sulcate above; tarsi fuscous. Length, 13.0-15.0 mm.

This very rare species of pentatomid has been recorded from Iowa by Osborn. He says, "A single specimen of this species has been taken by Mr. Ball at Little Rock, Lyon County."

(Proc. Ia. Acad. Sci., IV, 231, 1896.) Since that time I have not found specimens in the field but in looking over a student collection at Ames I discovered a nymph collected at that place in the summer of 1915.

As Van Duzee suggests (*l. c.*), this species "is probably confined to the Mississippi Valley and adjacent fertile plains." Stål's type came from Illinois. So far as I can learn, the only other locality records aside from the ones just mentioned are those of Uhler for Canada and Nebraska (*l. c.*) and the more recent record of Zimmer for Nebraska. He says (*l. c.*): "The only addition to this record [Uhler's] is a single male taken at West Point in October, 1884, by L. Bruner."

Genus CHLOROCHROA Stål

1872. CHLOROCHROA Stål, Svensk. Vet. Handl., 10, no. 4, 33.

Nine species are placed in this genus; six are found in the New World while three are Palaearctic in distribution. In the United States the genus apparently reaches its greatest development west of the Missouri river. A single representative has been recorded from Iowa. A summation of the principal diagnostic characters includes the following:

General form broader than *Rhytidolomia* and less produced anteriorly. Color clear green. Head and pronotum together forming a shorter and more obtuse angle than in that genus, the pronotum more depressed anteriorly. Rostrum not extending to posterior coxae, the second segment markedly longer than the third, the third and fourth subequal. Antennae long, slender, bearing at base a blunt rounded tooth which bears at its base a smaller tooth. Bucculae narrow, extending nearly to base of head, expanded into rounded flaps anteriorly. Humeral angles rounded, the postero-lateral margins nearly straight. Scutellum rather long but proportionately broader than in *Rhytidolomia*. Corium more or less rounded at outer posterior angle. Legs furnished with numerous hairs; basal tarsal segment of front legs very large, heavy.

Chlorochroa uhleri Stål

- 1856. †*Pentatoma ligata* Fitch, 3d Rept. Trans. N. Y. Sta. Agr. Soc., XVI, 389.
- 1872. *Lioderma (Chlorochroa) Uhleri* Stål, Svensk. Vet. Handl., 10, no. 4, 33.
- 1885. †*Pentatoma juniperina* Provancher, Faun. Can. Hém., III, 36.
- 1904. †*Pentatoma (Chlorochroa) juniperina* Van Duzee, Trans. Am. Ent. Soc., XXX, 39. (nec Linn.)
- 1904. *Pentatoma (Chlorochroa) Uhleri* Van Duzee, Trans. Am. Ent. Soc., XXX, 39.
- 1908. *Chlorochroa persimilis* Horvath, Ann. Mus. Nat. Hung., VI, 555.
- 1909. *Rhytidolomia (Chlorochroa) Uhleri* Kirkaldy, Cat. Hem. (Heterop.), I, 54.
- 1915. *Chlorochroa persimilis* Stoner, Ent. News, XXVI, 355.

General form broadly ovate, strongly convex above and below, the sides almost parallel to a point opposite apex of scutellum from which point the insect narrows gradually posteriorly. General color dark green to olive brown. Punctuation distinct, close, fairly fine and uniform. Head short, flattened above, closely, uniformly punctate, the juga blunt at apex, slightly surpassing tylus but not approaching before it; tylus very distinct; extreme lateral margins of head black, somewhat sinuate in front of eyes, the latter surrounded by a whitish calloused area of varying extent. Rostrum extending to posterior coxal margins, the second segment much longer than the third, the third and fourth subequal, the fourth with the apex black. Antennae black except basal segment and more or less of basal portion of second segment which are green; second segment much longer than third. Pronotum moderately narrowed anteriorly, the sides slightly, arcuated, sharply carinated, the punctuation regular, finer and closer anteriorly, gradually becoming coarser posteriorly; carinate margin and a uniform line just within pale yellowish to reddish; humeral angles prominent, broadly rounded. Scutellum broad at base, the apex not acutely narrowed, the tip well rounded; base with three pale calloused points, the apex pale yellowish to reddish; punctuation coarser towards base, becoming a little finer towards apex. Hemelytra uniformly punctate, the punctures at base and along costal margin a little finer than those on disk; costal margin varying from pale yellowish to reddish for about half its length; membrane hyaline, slightly exceeding abdomen, the nervures fuscous, heavy. Dorsum of abdomen black, the connexivum varying from pale yellow to reddish yellow, darkest on extreme margin and more or less distinctly scalloped within. Venter greenish yellow thickly covered with fine darker green punctures united by fine impressed lines thus giving an irregular finely strigose or aciculate effect; narrow mid-ventral line unsculptured, paler. Pleural pieces of thorax strongly, irregularly punctate. Legs greenish yellow, the tips of tibiae, the tarsi and the claws fuscous. Length, 11.0-14.5 mm. Width across pronotum, 6.5-8.5 mm.

While this species is quite different from and is not likely to be confused with any other Iowa pentatomid, it does resemble somewhat, other allied and extralimital forms from which, however, further differentiating characters need not be discussed here.

The usual variation in color and size obtains in *C. uhleri*, those individuals having the general coloration very dark greenish or brownish usually having the pale markings a deep red. Dark colored individuals are most likely to be met with in the autumn towards the close of the season.

So far as I am able to learn this insect was not reported from Iowa by Osborn, its first occurrence in the state being noted by the writer in 1915 (*l. c.*). It is a widely distributed form which

has been recorded from Maine to Mexico and Colorado. However, it is apparently not a common species in Iowa although it may be met with locally in some numbers. My specimens are from Chariton, Ft. Madison, Granite, Iowa City and Sergeant Bluff with by far the largest number from Iowa City. The Ft. Madison specimens are all nymphs, the largest of which is but half grown; they were taken June 30. Other nymphs not more than half grown have been taken in late October and early November. Of the seventy Iowa specimens at hand, including both nymphs and adults, less than ten have been taken earlier in the season than September 9; most have been collected during the month of October. Live hibernating specimens have not yet been taken but individuals which have not been able to survive our cold winter months have been found in March.

This bug has a great number of food plants and feeds upon many kinds of cultivated crops such as potatoes, radishes, turnips, peas, beans, cabbage, maize, wheat and oats. Some damage has been reported outside the state but in Iowa the insect is not present in sufficient numbers to be considered as a pest. The species also feeds on various kinds of thistle and I have taken it on gum-plant (*Grindelia squarrosa* (Pursh) Dunal.)

Genus *MORMIDEA* Amyot and Serville

1843. *MORMIDEA* Amyot and Serville, Hém., 134.

This small genus containing about forty species is confined to North and Tropical America and in the latter region reaches its greatest development. Six forms are recorded from North America all but one of which are confined largely to the South and Southwest. A single representative of the genus is found in Iowa. The principal generic characters may be thus briefly summarized:

Head triangular, somewhat elongate, the lateral margins not reflexed; sides of head sinuate in front of eyes, the antennal tubercles visible from above. Rostrum with second segment longest, the first segment surpassing slightly the bucculae which are parallel. Eyes globose, prominent. Lateral margins of pronotum smooth. Odoriferous orifices without a sulcus. Membrane surpassing the abdomen, the veins simple. Tibiae terete, not sulcate.

Two subgenera are recognized in the genus. The following subgenus in which our representative is placed, also contains a South American form. A free translation of Stål's diagnosis is given herewith.

Subgenus MELANOCHILA Stål

1872. *Melanochila* Stål, Svensk. Vet. Handl., 10, No. 4, 19.

Head somewhat deflexed anteriorly, black; bucculae concolorous. Thorax with a narrow abbreviated calloused band before the middle, the anterior angles without an outwardly directed tooth. Venter with lateral margins sub-calloused, the apical angles of the segments, excepting the angle of the sixth segment in the male, not very prominent.

Mormidea lugens (Fabricius)1775. *Cimex lugens* Fabricius, Syst. Ent., 716.1798. ||*Cimex albipes* Fabricius, Ent. Syst. Suppl., 535.1803. *Cimex gamma* Fabricius, Syst. Rhyng., 7. (Emend.)1805. *Pentatoma punctipes* Pal. Beauv., Ins. Afr. Amér., 113, Hém., Pl. 8, fig. 6.1825. ||*Pentatoma punctipes* Say, Journ. Acad. Nat. Sci. Phila., IV, 313. (as n. sp.).1840. *Cimex lugens* Herrich-Schaeffer, Wanz. Ins., V, 66, fig. 510.1859. ||*Pentatoma punctipes* Say, Compl. Writ., II, 241.1862. *Mormidea lugens* Stål, Stett. Ent. Zeit., XXIII, 103.1876. *Mormidea lugens* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 285.1880. *Mormidea lugens* Distant, B. C. A. Rhynch. Het., I, 54.1904. *Mormidea lugens* Van Duzee, Trans. Am. Ent. Soc., XXX, 42.

General form elongate ovate, narrowed, distinctly convex below, not so convex above. General color grayish olive. Head black, deeply, coarsely punctured, somewhat bronzed, the anterior half deflected abruptly, the median lobe more or less distinct entirely to base. Eyes black, very prominent. Antennae with three basal segments largely pale, the third and fourth segments pale only at bases, fuscous for most of their length; segments increasing in length progressively from first to fifth; all the segments covered with short white hairs. Rostrum pale yellow except median line and apical segment which are fuscous; second segment shortest. Anterior third of pronotum black, finely punctate; anterior submargin with a narrow, transverse, impunctate, abbreviated white line; anterior edge also with an abbreviated white line; lateral submargins white, impunctate, the extreme edge narrowly black; posterior portion of pronotum paler and more coarsely, irregularly punctate, the posterior angles not prominent, rounded. Scutellum black, slightly bronzed, rather sparsely, irregularly punctured, the terminal and lateral margins white with the extreme lateral edges black. Hemelytra coarsely, sparsely punctate, the narrow exterior basal margin yellowish white, the general surface olivaceous; membrane hyaline, the veins not prominent. Tergum black, finely, evenly punctate, the connexivum very narrow whitish. Venter blackish bronzed, thickly, deeply and rather regularly punctate, narrowly, regularly margined with white. Thoracic side pieces blackish bronzed, punctured, the coxal enlargements pale. Legs pale yellow to whitish with black points; apical tarsal segment and claws fuscous. Length, 6.0-7.5 mm. Width across pronotum, 3.0-4.0 mm.

The grayish olivaceous color with the two transverse, abbreviated, white lines on the pronotum anteriorly and the black scu-

tellum margined with white will at once serve to distinguish this widely distributed and locally abundant pentatomid. Locality records for Iowa are, Dubuque, Hills, Iowa City, Lake Okoboji, McGregor, Monticello, Robinson and Solon.

This species does not appear to be abundant in Iowa although it seems to be very hardy for specimens are at hand which have been taken in every month of the year except January and February. But two nymphs have been taken; one from Lake Okoboji less than half grown was collected July 17; the other which is more than half grown is from Iowa City and bears the date September 16.

Usually we have found this insect on Kentucky blue grass (*Poa pratensis* Linn.) growing along the edges of woods or in cleared places in the woods. Specimens have also been taken on common mullein (*Verbascum thapsus* Linn.) growing in pastures and open fields. The insects have a tendency to visit this plant especially towards autumn as the cold days come on, the dense wool which covers the leaves offering considerable warmth. Under these mullein stalks after a heavy freeze or in the spring one can usually find the remains of bugs which have sought shelter but have been unable to survive the rigors of an Iowa winter. Individuals which have successfully hibernated have been found under dead leaves along roadsides.

Genus SOLUBEA Bergroth

1862. ||OEBALUS Stål, Stett. Ent. Zeit., XXIII, 102.

1891. SOLUBEA Bergroth, Rev. Ent., X, 235.

This is a small genus confined exclusively to the New World and although represented in the Nearctic region it reaches its greatest development in the tropics. A single representative is found in Iowa. Essential diagnostic generic characters include the following:

Head elongate, more or less flattened above, the lateral margins somewhat reflexed; sides of head sinuate in front of eyes, the antennal tubercles visible from above. Rostrum with second segment longest, the first segment a little shorter than and entirely enclosed by the bucculae which are parallel. Eyes prominent. Lateral margins of pronotum more or less roughened. Membrane surpassing the abdomen, the veins simple, not prominent; outer posterior angles of abdominal segments sharp, prominent. Tibiae terete, not sulcate.

Solubea pugnax (Fabricius) (PLATE V, FIGURE 8)

1775. *Cimex pugnax* Fabricius, Syst. Ent., 704.
 1803. *Cimex typhoeus* Fabricius, Syst. Rhyng., 162.
 1805. *Pentatoma orthocantha* Pal. Beauv., Ins. Afr. Amér., 130, Hém., Pl. 9, fig. 9.
 1811. *Cimex typhoeus* Wolff, Ic. Cim., V, 176, fig. 174.
 1831. *Pentatoma augur* Say, Descr. Het. Hem., 3.
 1835. *Cimex vitripennis* Burm., Handb. Ent., II, 367.
 1851. *Mormidea typhoeus* Dallas, List Hem., I, 216.
 1857. *Pentatoma typhoeus* Guérin in La Sagra, Hist. de Cuba, Ins., 370.
 1859. *Pentatoma augur* Say, Compl. Writ., I, 313.
 1872. *Oebalus pugnax* Stål, Svensk. Vet. Handl., 10, no. 4, 22.
 1876. *Oebalus pugnax* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 285.
 1880. *Oebalus pugnax* Distant, B. C. A. Rhynch. Het., I, 56.
 1891. *Solubea pugnax* Bergroth, Rev. Ent., X, 235.
 1891. *Oebalus pugnax* Garman, Psyche, VI, 61.
 1904. *Oebalus pugnax* Van Duzee, Trans. Am. Ent. Soc., XXX, 43.

General form elongate, narrow, tapering gradually anteriorly and posteriorly from the humeral spines which are sharply pointed and directed forward. General color pale yellow to greenish yellow. Head elongate, pale yellow, somewhat flattened above, the median lobe slightly longer than the lateral lobes which are recurved at outer margins and edged with black; two vittae of deep black punctures extend through ocelli from base to apex of head; extreme base of head smooth. Antennae pale rufous, the first segment shortest and a little paler than the others; third segment longer than second. Rostrum pale yellow with median line and most of apical segment black. Pronotum narrowing distinctly anteriorly, the pale antero-lateral edges roughened, the acute humeral angles pointing upward and forward; rufous punctuation of disk sparse and more or less irregular, the punctures of the lateral margins dense and blackish. Scutellum long, coarsely, sparsely, irregularly punctate with black except tip and a more or less well defined median line; these are finely, sparsely punctate or entirely without punctures. Hemelytra greenish yellow, the punctuation black, finer and more sparsely arranged than on scutellum; costal margin and edge impunctate, pale yellow; exterior apical angle of corium with a black dot; membrane pale; tergum pale, the connexivum finely punctate, a little yellower than costal margin of hemelytra, the posterior angles of the segments sharply pointed. Venter pale yellow to reddish yellow with three vittae of black punctures which are more or less well defined on ventral thoracic plates also. Spiracles large and black thus giving the appearance of five vittae on the abdomen. A black spot on each coxal enlargement, one on outer angle of mesosternal sclerite and one just behind the short extension of the ostiolar canal. A black wavy line on prostethus behind each eye. Legs pale yellow with black points, the claws and distal portion of the last tarsal segment a little infuscate. Length, 10.5-11.5 mm. Width between humeral spines, 4.5-5.5 mm.

This pentatomid is very easily recognized among the others of our fauna by the elongate, narrow, linear form and by the long,

sharp humeral spines which are directed anteriorly. It is more particularly a southern species which apparently reaches its northern limits, in the Mississippi Valley at least, in central Iowa. Osborn records it from Ames (Proc. Ia. Acad. Sci., IV, 231, 1896) and the eight specimens now in my collection are from Hills, Iowa City and Moscow. All were collected between August 20 and October 23.

This insect seems to prefer vegetation growing in soil that is somewhat sandy. One specimen was swept from radishes growing in a sandy truck patch. The other specimens were taken from weeds growing in sandy and more or less gravelly soil along the edges of cultivated fields. Other food plants recorded for this species are maize (*Zea mays* Linn.), panic grass (*Panicum* sp.), foxtail grass (*Setaria* sp.) and wheat. It is also carnivorous to some extent and has been reported as feeding upon the larvae of the cotton worm (*Aletia*).

Genus *EUSCHISTUS* Dallas

1851. *EUSCHISTUS* Dallas, List Hem., I, 193 and 201

This is one of the largest genera of the Scutelleroidea and contains more than sixty species. It is Nearctic and Neotropical in distribution, eighteen forms being recorded from North America; of these, five have been taken in Iowa. The members of the genus exist under very different environmental conditions and are possessed of considerable adaptability. The chief diagnostic characters may be summed up as follows:

Body ovate. Apex of head rounded or emarginate; central lobe always reaching anterior margin of head but it may be longer than or surpassed by the lateral lobes; sides of head sinuate near eyes; eyes moderate. Ocelli small. Antennae of five segments, the basal segment short, stout, never surpassing apex of head; second segment usually shorter than third, the third, fourth and fifth segments about equal; antennal tubercles visible from above. Rostrum extending to posterior coxae, the basal segment not or scarcely reaching base of head. Pronotum with lateral angles prominent, sometimes rounded, sometimes acute and spinous; antero-lateral margins usually more or less crenulate (these margins are crenulate in all the Iowa forms). Scutellum triangular, not extending as far posteriorly as corium. Membrane with longitudinal nervures. Venter unarmed. Tibiae sulcate above. Tarsal segments three, of which the basal one is longest.

Subgenus *EUSCHISTUS* Dallas

1872. *EUSCHISTUS* Stål, Svensk. Vet. Handl., 10, no. 4, 26.

Key to the species

Pronotum without raised irregular line connecting the humeri

A minute black dot at lateral angles of ventral abdominal segments

Venter without black spots on median line

Juga not or very little longer than tylus leaving head rounded or truncate at apex.....*servus*

Juga distinctly longer than tylus leaving apex of head strongly incised*euschistoides*

Venter with a row of black spots, sometimes almost obsolete

Humeri rounded; antennae with fifth and apical half of fourth segments black.....*tristigmus*

Humeri acute or spinose; antennae entirely pale or rufous.....*tristigmus* var. *pyrrhocerus*

No black dot at lateral angles of ventral abdominal segments*variolarius*

Pronotum with a raised, impunctate, irregular line between humeri*ictericus*

Euschistus servus (Say)

1831. *Pentatoma serva* Say, Descr. Het. Hem., 4.

1837. *Pentatoma spilota* Westwood, Cat. Hope, I, 42.

1859. *Pentatoma serva* Say, Compl. Writ., I, 314.

1872. *Euschistus servus* Stål, Svensk. Vet. Handl., 10, no. 4, 26.

1877. *Euschistus servus* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 402.

1904. *Euschistus servus* Van Duzee, Trans. Am. Ent. Soc., XXX, 45.

General form broadly ovate, widest opposite apex of scutellum. General color pale yellow to reddish yellow, the upper surface rather finely, irregularly punctate, the juga a little longer than tylus, the margins of the head before the eyes slightly sinuate; a black line from eyes to base of antennae. Antennae pale yellowish to reddish yellow with black points; the two apical segments more or less dusky; second segment almost as long as third. Rostrum extending between posterior coxae. Pronotum more irregularly, sparsely punctate on anterior half, the antero-lateral edges crenulate and concavely arcuated; humeri prominent but not angulate. Scutellum broad at base, irregularly punctate with black, the punctures finer towards the tip; apex whitish. Hemelytra more closely and deeply punctate, the punctuation of corium more regular than that of embolium; membrane dusky dotted with fuscous, the nervures simple, distinct. Tergum blackish with irregular yellowish spots at margins. Venter pale yellowish, irregularly punctured with reddish, minutely rugulose and with a black point at the postero-lateral edge of each incisure; no distinct black spot or row of spots on median line. Ventral thoracic plates coarsely irregularly punctate.

tate with sometimes a black point near the middle of each. Legs pale yellow with black points, the tibiae furnished with numerous, short, rather heavy and acute spines; tarsi pale clay yellow, the second segment smallest, the first largest; apices of tarsal segments and tarsal claws dusky. Length, 12.5–15.0 mm. Width across humeri, 7.0–9.0 mm.

This form resembles somewhat the following species, *E. euschistoides*, but the apex of the head is not at all or at most only very slightly incised, the maculated margins of the abdomen project beyond the hemelytra, thus giving the insect a more robust appearance and the punctuation of the embolium is deeper and coarser. In addition, the sinuation at the sides of the head before the eyes is not so well marked as in *E. euschistoides*.

Euschistus servus seems to be more characteristic of our southeastern states where it replaces the more northern form *euschistoides*; the two forms are very closely allied and a tendency to intergradation seems to be manifest.

While Osborn reported a single specimen of *E. servus* from Iowa (Proc. Ia. Acad. Sci., I, Pt. II, 121, 1892), the record is not satisfactory; it reads as follows, "One spec. Loc. ?". After a careful study of my material I find that I have but one Iowa specimen which I can with certainty attribute to this species; it is a female taken at Iowa City, October 1. The species has been reported as feeding on maize (*Zea mays* Linn.) and orange (*Citrus aurantium* Linn.) and it probably also feeds on various plants and grasses as do its congeners.

Euschistus euschistoides (Vollenhoven)

- 1868. *Diceroeus euschistoides* Vollenhoven, Verls. Ak. Amst. Nat. (2), II, 180.
- 1871. *Euschistus fissilis* Uhler, Proc. Bost. Soc. Nat. Hist., XIV, 96.
- 1872. *Euschistus fissilis* Uhler, Report U. S. Geol. Surv., V, 396.
- 1872. *Euschistus fissilis* Stål, Svensk. Vet. Handl., 10, no. 4, 26.
- 1878. *Euschistus fissilis* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 374.
- 1904. *Euschistus fissilis* Van Duzee, Trans. Am. Ent. Soc., XXX, 44.
- 1909. *Euschistus euschistoides* Kirkaldy, Cat. Hem. (Heterop.), I, 64.

General color of *E. servus*. Form narrower than that species, the abdomen not extending beyond the sides of the hemelytra; body above distinctly depressed, below markedly convex. Apex of head deeply incised but the lateral lobes do not meet in front; punctuation of the head a little coarser than in *E. servus* and the sinuation before the eyes more marked than in that form; a black line from eyes to base of antennae. Antennae reddish yellow, the apical three-fourths of the third segment and all but the very narrow base of the fourth segment fuscous to black; second segment distinctly shorter than the third. Rostrum extending between posterior

coxae. Pronotum more finely, irregularly and sparsely punctate on anterior half, the antero-lateral edges concavely arcuated and denticulate; humeri prominent, rounded, not angulate. Scutellum long, irregularly punctate with black, the punctures a little finer and more sparsely arranged towards tip; usually a more or less distinct, impunctate, calloused area on median line at base; apex pale. Hemelytra with irregularly arranged fuscous punctures, the area between the punctures somewhat coarsely aciculate; punctuation of embolium more regular and a little closer and finer than that on corium, thus differing in this respect from *E. servus*; membrane dusky, dotted with fuscous, paler towards tip. Tergum blackish, the margins regularly pale but not showing beyond the hemelytra. Venter pale yellowish, finely punctate and very finely aciculate; without black points at the outer posterior edges of the incisures. Ventral thoracic plates coarsely, irregularly punctate. Sometimes the whole inferior surface is sprinkled with red specks which become larger on the thoracic plates. Legs reddish yellow with large black points, the tibial spines rather numerous toward apex; tarsi pale yellowish, the apices of the segments and tips of the claws fuscous. Length, 12.0-14.0 mm. Width across humeri, 7.0-8.5 mm.

The nearest ally of this form in our fauna is *E. servus* but the following salient differences are to be noted: *E. euschistoides* has the abdomen narrower and entirely covered by the hemelytra, the apex of the head deeply incised, a finer, less dense punctuation on the embolium, a comparatively shorter second antennal segment and no black points at the incisures. Other differentials are indicated in the description.

With this species as with other members of the genus, considerable variety in color occurs, the variation extending all the way from pale yellow to dark reddish brown. As cold weather comes on in the fall more individuals of this darker color are to be observed. At that season specimens are often to be found under dried leaves.

This member of the genus has been recorded as "common" by Osborn and at the present time it retains this status in the state. Numerous examples are at hand from Amana, Estherville, Fairfield, Hamburg, Indianola, Iowa City, Lake Okoboji, McGregor, Monticello, Robinson and Sioux City. Adults have been taken from April 24 to November 6 and are most abundant in June and September. All the nymphs of this species have been taken in July. Two broods in a season are indicated from the data at hand.

We have taken specimens oftenest by sweeping in fields of red clover and timothy, particularly in low places. Maize and wheat are recorded as additional food plants. The bug is also said to feed on the larvae of the cotton moth, *Aletia* sp.

Euschistus tristigmus (Say) (PLATE VI, FIGURE 7)

- 1831. *Pentatoma tristigma* Say, Descr. Het. Hem., 4.
- 1837. *Pentatoma inconspicua* Westwood, Cat. Hope, I, 42.
- 1851. *Euschistus luridus* Dallas, List Hem., I, 207, Pl. VII, fig. 6.
- 1859. *Pentatoma tristigma* Say, Compl. Writ., I, 314.
- 1872. *Euschistus tristigmus* Stål, Svensk. Vet. Handl., 10, no. 4, 26.
- 1876. *Euschistus tristigmus* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 286.
- 1880. *Euschistus tristigmus* Distant, B. C. A. Rhynch. Het., I, 58.
- 1904. *Euschistus tristigmus* Van Duzee, Trans. Am. Ent. Soc., XXX, 47.
- 1909. *Euschistus tristigmus* Kirkaldy, Cat. Hem. (Heterop.), I, 66.

Ovate, grayish or brownish, rather closely and finely punctured with black; a few small, irregular calloused areas. Head densely, rather regularly punctate, the juga not longer than the tylus, the margins of head before eyes only slightly sinuate; a black line from eyes to base of antennae. Antennae rufous, the apex of fourth segment and the fifth, except at base, blackish. Rostrum extending behind posterior coxae, pale yellowish, the tip black. Pronotum densely punctate with black along anterior and antero-lateral margins, the edges of the latter pale, denticulated and concavely arcuated; humeri prominent, rounded. Scutellum rather densely, finely punctate, the base with three more or less distinct calloused spots, the tip whitish. Hemelytra narrower than abdomen, the corium more closely and deeply punctate than the embolium and finely aciculate, with a few calloused impunctate areas; embolium rather closely and finely punctured to costal edge; membrane brownish with a number of more or less distinct brown spots; a dusky spot on each hemelytron and one near the middle of the scutellum. Tergum black, the margins of the abdomen black, the edges yellowish or reddish and a large spot of the same color at the middle of each segment. Venter yellowish or reddish yellow, finely punctured with reddish and finely aciculate; a black spot at each incisure; a series of black spots on the middle of each of the four last segments, the posterior spot largest and more or less oval in outline; in some specimens two or three of these spots are wanting but the black spot on the apical segment is always present; the smallest spot is nearest the base and the others grade larger posteriorly. Ventral thoracic plates coarsely punctured with red. Legs yellowish with numerous black dots, the tibiae and under sides of femora furnished with sharp black spines; tarsal segments and claws fuscous at apices. Length, 10.0-12.0 mm. Width across humeri, 6.5-7.5 mm.

In some individuals the black spots on the middle of the venter are fused to form a line, while in other specimens the single spot on the last segment is much reduced and very faint. The tendency to fusion of these spots seems to be more prevalent

among the males. The extent of the rufous on the fourth antennal segment also varies considerably, some specimens showing only a little at the base of the segment while in others more than half of the segment is rufous. Some specimens show only a trace of the dusky spots on hemelytra and scutellum but others, particularly the lighter colored ones, show this character plainly.

This is one of our common representatives of the genus and many specimens are at hand from Ames, Decorah, Independence, Iowa City, Lake Okoboji, Osage, Robinson, Silver Lake, Sioux City, Homestead and Solon. The adult specimens bear collecting dates ranging from March 11 to November 13 with the greatest number taken in August while the number taken in July runs somewhat behind. Nymphs have been taken mostly in July and August and in favorite habitats are often abundant at that season.

Ordinarily this bug is found in or along more or less wooded and shady places and moist situations grown up in rank weeds and bushes. At Lake Okoboji it is one of the commonest woodland forms and occurs most frequently on wild black raspberry (*Rubus occidentalis* Linn.) on which plant numerous examples have also been taken in other parts of the state. Sometimes it occurs on wild red raspberry (*Rubus idaeus* Linn. var. *aculeatissimus* (C. A. Mey) R. and I.) and not infrequently are specimens found on the cultivated plants in our gardens. In late summer the species is also found on hazelnut bushes (*Corylus americana* Walt.). Adults are often found hibernating under leaves in the vicinity of clumps of such bushes.

Euschistus tristigmus var. *pyrrhocerus* Herrich-Schaeffer (PLATE VI, FIGURE 6)

1842. *Cimex pyrrhocerus* Herrich-Schaeffer, Wanz. Ins., VI, 71, fig. 638.

1904. *Euschistus tristigmus* var. *pyrrhocerus* Van Duzee, Trans. Am. Ent. Soc., XXX, 47.

1916. *Euschistus tristigmus* var. *pyrrhocerus* Stoner, Ent. News, XXVII, 182.

Closely allied and very similar to *E. tristigmus* but the general form narrower and more elongate, thus giving the insect a trim appearance. The punctuation above is a little finer and the irregular calloused spots more pronounced. Antennae averaging a little paler than in *E. tristigmus* and with the two apical segments little or not at all darker than the other segments. Antero-lateral angles of the pronotum more concavely arcuated

than in that species and with the humeri produced, either acute or spinose. Venter and legs also averaging paler. The ventral row of black spots is not so pronounced and in some specimens is reduced to a narrow longitudinal line on the last segment.

This insect is more particularly southern in its distribution and but few specimens have been taken in the state. It was first recorded from Iowa by the writer in 1916 (*l. c.*). Six specimens are at hand from Iowa City and Solon. As with the preceding form, thickets along the edges of woods and fence rows seem to be the favorite haunts. All of the specimens have been taken in September from wild black raspberry (*Rubus occidentalis* Linn.). This is the smallest of our representatives of the genus *Euschistus*.

Euschistus variolarius (Palisot de Beauvois) (PLATE I, FIGURE 5, PLATE III, FIGURE I, PLATE IV, FIGURE 1, and PLATE VI, FIGURE 4)

- 1805. *Pentatoma variolaria* Pal. Beauv., Ins. Afr. Amer., 149, Hém., Pl. 10, fig. 6.
- 1825. ||*Pentatoma punctipes* Say, Journ. Acad. Nat. Sci. Phila., IV, 314.
- 1842. ||*Cimex sordidus* Herrich-Schaeffer, Wanz. Ins., VI, 70, fig. 637.
- 1842. †*Cimex ictericus* Herrich-Schaeffer, Wanz. Ins., VI, 71, fig. 639.
- 1844. ||*Pentatoma sordidus* Herrich-Schaeffer, Wanz. Ins., VII, 95.
- 1844. †*Pentatoma ictericus* Herrich-Schaeffer, Wanz. Ins., VII, 95.
- 1851. ||*Euschistus punctipes* Dallas, List Hem., I, 207.
- 1859. ||*Pentatoma punctipes* Say, Compl. Writ., II, 241.
- 1872. *Euschistus variolarius* Stål, Svensk. Vet. Handl., 10, no. 4, 26.
- 1904. *Euschistus variolarius* Van Duzee, Trans. Am. Ent. Soc., XXX, 47.
- 1905. *Euschistus variolarius* Forbes, Rept. Ent. Ills., XXIII, 195.

General form ovate, robust. General color greenish yellow to light brownish with distinct but rather fine fuscous or black punctures. Head rather densely punctate, the lateral lobes sometimes slightly longer than, sometimes a little shorter than the median lobe; sinuation at sides of head before eyes not well marked; an oval, yellowish, impunctate area above the eyes. Antennae pale yellowish to reddish yellow, the apical portion of the fourth segment and the entire fifth segment fuscous or black; second segment shorter than third. Rostrum pale clay yellow, extending between posterior coxae. Pronotum more finely punctate on anterior half, the antero-lateral margins pale, concavely arcuate and regularly dentate, the humeral angles more or less acute, almost spinose. Scutellum a little more densely punctate than pronotum, the apex slender, the extreme tip pale and scarcely or not at all punctate. Hemelytra punctured about like scutellum, the punctures more or less aggregated in places leaving irregular calloused areas between; embolium a little more finely and closely punctate than corium; membrane whitish, furnished with many orbicular brownish spots. Tergum blackish, the margins pale and extending slightly

beyond hemelytra. Venter pale yellowish, sometimes yellowish green, finely punctate and aciculate, the outer posterior edges of the incisures without distinct black spots; male with a rounded black spot on the last segment beneath; this spot sometimes extends a little on the posterior edge of the preceding segment; the female unmarked in this respect. In most specimens, both male and female, the venter is more or less flecked with red. Ventral thoracic plates pale yellow, closely but coarsely punctate. Legs a little darker, more or less spotted with black or fuscous, the tibiae and under sides of femora with a few small, sharply pointed, black spines. Tarsal segments and claws more or less infusate at apices. Length, 11.5–14.0 mm. Width across humeri, 8.0–9.0 mm.

This is by far our commonest representative of the genus and, indeed, in most seasons, it is our commonest pentatomid, with *P. limbolarius* running it a close second; sometimes the latter is unusually abundant so that the present species is forced to take second place. *E. variolarius* may be distinguished from its congeners in our fauna by the absence of black points at the incisures on the edges of the abdomen, the usually rounded anterior margin of the head, the entirely black apical segment of the antennae with the fourth segment also largely black, and the prominent oval blackish spot on the genital segment of the male. It averages a little smaller than *E. euschistoides* or *servus*. The humeri vary from subacute to almost spinose and the color varies from pale yellow to light brown.

This species, known everywhere as the "stink bug" or "berry bug," has been taken in every locality visited in the state. Individuals have been found walking about on warm days in February and as late in autumn as November. Specimens have been taken in every month of the year except January and December. July, August and September are the months of greatest abundance of both adults and nymphs. Adults frequently hibernate under rocks, sticks and rubbish in more or less sheltered and out of the way places which have been permitted to grow up in weeds during the summer.

These bugs are sometimes attracted to electric street lights in considerable numbers. On the evening of May 25, 1916, a number of specimens were taken in Iowa City at the electroliers near the University armory. Although the night was warm and sultry no other pentatomids were taken at this time. Specimens have been taken at street lights on other occasions.

Ordinarily, during the summer, fields of red clover and timothy are favorite haunts of this bug and most of our specimens have been taken in such situations. A long list of food plants is known and on account of its large size and great numbers it frequently does some injury to infested plants. Forbes says (*l. c.*), "We have repeatedly found it on corn, sucking sap from the leaves, from the husks and kernels at the tip of the ear, and from other parts of the plant. . . . We have also taken the adults on rye, red clover, broom corn, oats, thistle, grasses and flowers; and they have been reported to eat tomatoes, red raspberries, peaches, mullein, and *Thermopsis*." Lugger (Rept. Minn. Exp. Sta., VI, 1900, 91) reports this insect as destructive to asparagus and wheat. I have found both nymphs and adults very common on red clover at Iowa City in June. Usually the bugs attack the plants down near the bases on the less tough and more delicate leaves and stems. I have also taken the adults often on potato, ragweed (*Ambrosia artemisiifolia* Linn.) and burdock (*Arctium minus* Bernh.). In addition, the species is said to feed on lepidopterous larvae and upon the cottony maple scale (*Pulvinaria innumerabilis* Rathv.).

Euschistus ictericus (Linnaeus)

1763. *Cimex ictericus* Linnaeus, *Cent. Ins.*, 16.

1763. *Cimex ictericus* Linn., *Amoen. Acad.*, VI, 399.

1767. *Cimex ictericus* Linn., *Syst. Nat.*, XII, 719.

1805. *Pentatoma rubro-fusca* Pal. Beauv., *Ins. Afr. Amér.*, 185, Hém., Pl. 11, fig. 3.

1851. *Euschistus cognatus* Dallas, *List Hem.*, I, 204.

1872. *Euschistus ictericus* Stål, *Svensk. Vet. Handl.*, 10, no. 4, 26.

1904. *Euschistus ictericus* Van Duzee, *Trans. Am. Ent. Soc.*, XXX, 47.

General form as in *E. variolarius* but averaging a little more slender. Color pale grayish to reddish yellow, a little more finely punctate with black than *E. variolarius*. Tylus usually slightly longer than juga. Humeral angles strongly spinous and acute, more produced than in *E. variolarius*; a transverse, impunctate calloused line, more or less sinuate in the middle, connects the humeri; pronotum behind this keel more or less rugose. Scutellum closely punctured. Hemelytra a little more sparsely punctured; furnished with a few small groups of closely set punctures. Venter impunctate except along margins but finely, regularly, aciculate and more or less flecked with red as are also the ventral thoracic plates. Margins of abdomen without black points; last ventral segment of male without black spot. A black dot at the base of each coxal cavity and in addition one near the middle of the mesostethus. Other characters as in *E. variolarius*.

This form is closely allied to *E. variolarius* and to avoid

duplication of statements a detailed diagnosis is omitted and only the principal differentials are included above.

Osborn records this species from the state with the following comment: "One specimen, doubtless taken in the State, in collection of H. H. Raymond." (Proc. Ia. Acad. Sci., I, Pt. II, 121, 1892.). During the course of our work but seven specimens have been taken at Algona, Lake Okoboji and Sioux City. Such habitats as are chosen by *E. variolarius* are likely to yield specimens of this form.

Genus COENUS Dallas

1851. COENUS Dallas, List Hem., I, 194 and 230.

But a single species, the distribution of which is confined to North America, is included in this rather unique genus. Only the principal diagnostic characters are herewith given.

Body ovate, somewhat convex above and very convex beneath. Head slightly convex on dorsal surface, the apex rounded, the tylus reaching the anterior margin; sides of head sinuate in front of eyes. Antennae with basal segment shortest and apical segment longest. Rostrum extending between posterior coxae, the basal segment a little shorter than the parallel bucculae. Pronotum with lateral margins smooth, the lateral angles rounded, not produced. Scutellum broadly rounded at apex. Hemelytra with inner half of apical margin parallel with margin of scutellum, the outer half rather abruptly transverse, the inner angle rounded; veins of membrane reticulate. Abdomen unarmed at base. Tibiae furnished with moderate spines; basal tarsal segment as long as the two apical segments together. Ostiolar opening without sulcus.

Coenus delius (Say) (PLATE V, FIGURE 10)

- 1831. *Pentatoma delia* Say, Descr. Het. Hem., 8.
- 1843. *Hymenarcys aeruginosa* Amyot and Serville, Hém., 125.
- 1851. *Coenus tarsalis* Dallas, List Hem., 230, Pl. 8, fig. 6.
- 1859. *Pentatoma delia* Say, Compl. Writ., I, 320.
- 1868. *Coenus punctatissimus* Vollenhoven, Versl. Ak. Amst. Nat., (2), II, 183.
- 1872. *Coenus delius* Stål, Svensk. Vet. Handl., 10, no. 4, 30.
- 1878. *Coenus delius* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 376.
- 1904. *Coenus delius* Van Duzee, Trans. Am. Ent. Soc., XXX, 49.

General form ovate, widest behind middle. Color pale yellow to yellowish brown, sometimes slightly suffused with pinkish; covered with large, deep black punctures which are massed closer together on either side of the median carina of head and on the submargins of pronotum. Head narrow, elongate, somewhat convex, with median, impunctured, pale carina which is less prominent on posterior third. Antennae dark rufous, fifth segment and apical half of fourth fuscous; basal segment shortest, second a little longer, third longer than second, fourth shorter than third but longer than second, the fifth longest. Rostral sheath pale yellow, the

bristles fuscous. Pronotum coarsely, irregularly punctate, the antero-lateral margins straight, pale yellowish, usually impunctate but sometimes with faint reddish punctures; extreme edges black; humeri rounded, not prominent. Scutellum coarsely, irregularly punctured, not much narrowed towards apex which is broadly rounded. Hemelytra coarsely punctate, broadly rounded at tip, usually not quite as wide as abdomen; membrane whitish, the veins forming an irregular network. Tergum black, closely, regularly punctured; margin yellowish, not as sparsely punctate. Beneath yellowish, the side pieces of the thorax sparsely and deeply punctured, the abdominal segments, especially the apical ones, more finely and closely punctured. Legs yellowish, thickly dotted with fuscous, the tibiae with numerous, moderately stout spines and a few on the under side of the femora. Length, 8.5-11.0 mm. Width across humeri, 4.5-6.5 mm.

This pentatomid may be distinguished from the other representatives of our fauna by the smoothly convex oval form, widest behind the middle, the slightly convex head with the prominent, impunctate but finely, transversely creased median carina, the rounded humeri which are not wider than the hemelytra and the irregularly reticulate venation of the wing membrane.

Professor Osborn recorded *Coenus delius* as rare in Iowa. However, many specimens are in our collection from Algona, Ames, Clarion, Des Moines, Emmetsburg, Estherville, Fairfield, Hills, Indianola, Iowa City, Lake Okoboji, Marengo, Nichols, Sac City, Sioux City, Solon and Waukon.

Timothy and clover fields, particularly those in more or less moist situations, are the places most frequently chosen by this insect. The vegetation of semicultivated roadsides will frequently harbor it in some numbers, especially if there is more or less timothy and blue grass present. Low lying blue grass pastures are also favored habitats.

Hibernating forms are not uncommon and specimens may be found in early spring under boards, sticks and rubbish in pastures and along the grassy edges of fields. Our earliest spring record is February 27.

Judging from the material at hand this species breeds rather later in the year than most of our pentatomids and it appears to be single brooded with us. All the nymphs have been taken in July. At Lake Okoboji in the summer of 1916 adults were not taken earlier than July 4 and nymphs in all stages were moderately common during that month.

Genus HYMENARCYS Amyot and Serville

1843. HYMENARCYS Amyot and Serville, Hém., 124.

This small genus containing but four forms is chiefly Ne-arctic in distribution. The two species which are found in Iowa also enjoy a wide range in North America while the other two species have as yet been recorded only from Arizona and Mexico. The principal diagnostic characters of the genus follow:

Head only slightly convex on dorsal surface; apex rounded. Rostrum extending a little behind midcoxae. Juga without lateral tooth. Bucculae gradually increasing in height posteriorly. Pronotum unarmed, the humeri rounded but not expanded. Scutellum with apex only moderately narrowed and not extending posteriorly as far as corium; the latter with a distinct and more or less acute apical angle; membrane with nervures irregularly furcate or reticulate. Odoriferous orifices well outside the coxae and not continued in a sulcus.

Key to the species

Veins of membrane irregularly furcate but not anastomosing; lateral margins of pronotum straight; length, 7.0–9.0 mm.

..... *aequalis*

Veins of membrane anastomosing; lateral margins of pronotum arcuate; length, 9.0–11.5 mm..... *nervosa*

Hymenarcys aequalis (Say)

1831. *Pentatoma aequalis* Say, Descr. Het. Hem., 7.

1839. *Cimex dentatus* Herrich-Schaeffer, Wanz. Ins., V, 64, fig. 607.

1844. *Pentatoma dentatus* Herrich-Schaeffer, Wanz. Ins., VII, 95.

1851. *Pentatoma bozura* Dallas, List Hem., I, 244.

1859. *Pentatoma aequalis* Say, Compl. Writ., I, 319.

1872. *Hymenarcys aequalis* Stål, Svensk. Vet. Handl., 10, no. 4, 30.

1904. *Hymenarcys aequalis* Van Duzee, Trans. Am. Ent. Soc., XXX, 49.

General form ovate, narrowed. Color yellowish to pale brown with numerous, rather large and regularly arranged black punctures. Head long, narrow, the median lobe elevated and finely punctate, slightly longer than the lateral lobes which are rounded at antero-lateral margins; lateral sub-margins more thickly, finely punctured than rest of head. Eyes prominent. Antennae yellowish to brownish, thickly covered with small, closely set black dots; second and third segments about equal. Rostrum extending to posterior coxal border, moderately stout, the third segment somewhat infusate, the apical segment black; first and second segments pale yellow with black median line. Pronotum more closely and regularly punctate on posterior half, the antero-lateral margins almost straight, the edges a little roughened anteriorly; humeri rounded, not prominent. Scutellum rounded at tip and contracted only moderately before it; irregularly punctate, the punctures towards apex a little finer and closer; apex at middle blackish with an elongate pale spot on either side. Hemelytra narrower than abdo-

men, a little more finely punctate than scutellum; membrane dusky white to hyaline with a few brown spots, the venation sometimes not distinct but always irregularly furcate. Tergum black, closely and distinctly punctured towards apex, the margins alternated with pale orange and black. Beneath yellowish to grayish brown with a fulvous tinge. Venter thickly and finely punctate with brownish, the stigmata and a more or less indistinct, irregular band on each side blackish. Ventral thoracic plates much more coarsely and sparsely punctured. Legs yellowish, thickly covered with brown points; trochanters paler; tibiae tipped with brownish. Length, 7.0-9.0 mm. Width across pronotum, 3.5-4.5 mm.

With the exception of *Neottiglossa sulcifrons* this is our smallest representative of the subfamily Pentatominae and may be easily distinguished from any other species in our fauna by the characters given above. It was recorded as not common by Osborn and this statement apparently also indicates its status at the present time, although it is the more common of our two Iowa representatives of the genus. Specimens are at hand from Bayfield, Cerro Gordo county, Corydon, De Witt, Hampton, Hills, Indianola, Iowa City, Monticello and Red Oak.

Comparatively few of the seventy specimens thus far obtained have been taken in sweeping, most of them having been collected either late in the fall or early in spring in places which they had chosen for hibernation. Individuals have been found under small rocks in more or less sheltered situations as early as February 13, before the frost and ice in these places had melted. During the summer these rocky places were grown up in weeds and grass. Hibernating specimens have often been taken from beneath leaves along the edges of woods; loose sticks and boards in meadows also offer shelter during the winter months. Sometimes specimens are found under the loose bark of decaying stumps of trees and under the dead leaves of mullein plants. On warm sunshiny days in late autumn and early spring specimens may often be found walking about on the sidewalks of cities. Our latest seasonal record is December 3. The few specimens taken with the sweep net were on low weeds and usually in more or less moist places. Nymphs of this species have not been discovered.

Hymenarcys nervosa (Say)

1831. *Pentatoma nervosa* Say, Descr. Het. Hem., 9.

1837. *Pentatoma pennsylvanica* Westwood, Cat. Hope, I, 35.

1843. *Hymenarcys perpunctata* Amyot and Serville, Hém., 124.

1859. *Pentatoma nervosa* Say, Compl. Writ., I, 321.
1872. *Hymenarcys nervosa* Stål, Svensk. Vet. Handl., 10, no. 4, 31.
1876. *Hymenarcys nervosa* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 287.
1904. *Hymenarcys nervosa* Van Duzee, Trans. Am. Ent. Soc., XXX, 49.
1909. *Hymenarcys nervosa* Kirkaldy, Cat. Hem. (Heterop.), I, 72.

General form rather broadly ovate. Color reddish brown to rufous with large, distinct and regularly arranged black punctures. Punctuation of head finer and closer. Head somewhat flattened above, the sinuation before the eyes pronounced; juga not longer than tylus, the latter distinctly elevated, impunctate on the middle and feebly so at the margins. Antennae reddish yellow to rufous, the entire apical segment and apical half of fourth segment dusky; second segment little more than half the length of third. Rostrum yellowish with black median line and apical segment; extending just behind midcoxae. Pronotum rather coarsely, regularly punctate, the antero-lateral margins a little convexly arcuated; humeri slightly prominent, obtusely rounded. Scutellum short, regularly punctate, a more or less distinct impunctate yellowish area on median line at base and at each basal angle; lateral edges at base rounded leaving an interval between basal angles and pronotum; apex rather broadly rounded, the tip narrowly pale. Hemelytra a little more finely punctured than scutellum; membrane brownish, the irregularly anastomosing nervures darker. Tergum blackish, rather finely, irregularly punctate, the margins which project considerably beyond hemelytra alternated with yellow and black. Beneath pale yellowish to rufous with large black punctures on thoracic plates and smaller red ones on abdomen; a broad and more or less interrupted blackish vitta extends backwards on either side from the eye to near the apex of the venter where it becomes obsolete; a black spot both posterior and anterior to each incisure at the margins; last ventral segment of female with a more or less distinct blackish median vitta. Legs yellowish with numerous black dots. Length, 9.0–11.5 mm. Width across pronotum, 5.5–7.0 mm.

This is the larger and more broadly ovate representative of the genus in Iowa. Osborn recorded it as "Usually rare" in the state and we have found it in but few places, Burlington, Iowa City and Red Oak being our only locality records.

As with the preceding form, most of the specimens taken have been hibernating individuals captured either in early spring or late fall. Specimens have been found in early February under stones in waste places overgrown with weeds and vegetation during the summer. Several living specimens have been picked out of the frozen soil in such situations. Hibernating specimens have often been found under leaves in semi-wooded areas and under boards and sticks in pastures.

In briefly discussing this form Uhler says: "Like *Euschistus variolarius* and other species it becomes, when senile, suffused with red, is dusted with a whitish powder, and seems then to have a more decidedly penetrative odor in the fluid which it sprays from the aperture of its glands." (*l. c.*) In the South this bug is said to feed upon cotton.

Genus NEOTTIGLOSSA Kirby

1837. NEOTTIGLOSSA Kirby, Rich. Faun. Bor. Am., IV, 276.

This is a small genus containing about fifteen forms of which but four are found in America, the remainder being Palaearctic in distribution. Two representatives are found in Iowa. Included among the principal generic characters are the following:

Head triangular, very convex on dorsal surface, the juga distinctly longer than tylus. Pronotum with a more or less distinct median longitudinal ridge; cephalic angles of pronotum not projecting forward. Scutellum not acutely narrowed at apex. Apex of corium broadly rounded. Tibiae faintly sulcate.

Each of our two Iowa forms is placed in a distinct and readily recognizable subgenus. The characters given are adapted from Stål.

Subgenus NEOTTIGLOSSA Kirby

1872. NEOTTIGLOSSA Stål, Svensk. Vet. Handl., 10, no. 4, 18.

Head within lateral margins less tumescent, not incised before the eyes but gradually contracted before them; a pale subcalloused vitta extends posteriorly; sometimes it is less densely punctate than tylus; bucculae pale. Ostiolar orifices continuing outwardly in an oblique wrinkle.

Subgenus TEXAS Kirkaldy

1904. TEXAS Kirkaldy, Entomol., XXXVII, 280 (n. name for *Melanostoma* Stål).

1909. TEXAS Kirkaldy, Cat. Hem. (Heterop.), I, 79 and 80.

1872. *Melanostoma* Stål, Svensk. Vet. Handl., 10, no. 4, 18.

Head within the lateral margins strongly tumid, subincised towards the eyes, more distinctly near the eyes, entirely, densely punctured; no distinct pale vitta as in the preceding; bucculae concolorous, black. Ostiolar orifices continuing outwardly in a distinct wrinkle.

Key to the species

Upper surface of head almost flat transversely, not tumidly elevated within lateral margins; bucculae pale, punctured;

length, 4.5-5.5 mm.....(Subgenus *Neottiglossa*) *undata*
 Upper surface of head strongly tumid within lateral margins;
 bucculae entirely black; form more slender; length, 4.0-4.5
 mm.....(Subgenus *Texas*) *sulcifrons*
Neottiglossa undata (Say)

1831. *Pentatoma undata* Say, Descr. Het. Hem., 8.
 1859. *Pentatoma undata* Say, Compl. Writ., I, 319.
 1872. *Neottiglossa undata* Stål, Svensk. Vet. Handl., 10, no. 4, 18.
 1878. *Neottiglossa undata* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 376.
 1903. *Mormidea undata* Macgillivray and Houghton, Ent. News, XIV, 263.
 1904. *Neottiglossa undata* Van Duzee, Trans. Am. Ent. Soc., XXX, 50.
 1915. *Neottiglossa undata* Stoner, Proc. Ia. Acad. Sci., XXII, 353.

General form elongate oval, narrowed, not contracted much posteriorly. Color dull yellowish with pale yellowish markings and fairly regularly arranged deep black punctures. Head very convex, coarsely, irregularly punctate, the calloused median line more or less impunctate, the punctures finer and closer on either side of it; edges of head undulate; anteriorly the head is rather abruptly narrower and the juga are much longer than the tylus, approaching but usually not uniting, thus leaving a deep, narrow incisure. Antennae with three basal segments yellowish, the two apical segments blackish rufous; second segment longer than third. Rostrum dull yellowish, extending between posterior coxae; apical segment blackish. Pronotum more coarsely punctate on anterior half, the pale yellowish median line and lateral margins impunctate, the lateral edges straight, blackish; humeri rounded, a little swollen. Scutellum rather large, gradually becoming more finely punctate towards apex which is broadly rounded and not much narrowed; a median, impunctate, pale yellowish calloused line and a similar abbreviated line at each basal angle. Hemelytra regularly punctate, as wide as abdomen, the apex broadly rounded, somewhat sinuate; membrane whitish. Tergum black, punctured, with a pale yellowish impunctate margin. Venter brownish black, slightly bronzed, deeply, coarsely, rather regularly punctate, the margin pale yellow. Ventral plates of thorax brownish maculated with yellowish and coarsely, irregularly punctate. Legs yellowish with irregular black points; apical tarsal segment and tarsal claws infusate. Length, 4.5-5.0 mm. Width across pronotum, 3.0-3.5 mm.

Neottiglossa undata is readily distinguishable from any of our other pentatomids by its regularly elongate oval outline and trim appearance along with the characters mentioned above. Osborn listed it as "Not common" in Iowa (Proc. Ia. Acad. Sci., I, Pt. II, 121, 1892), but in our experience it has usually been common in suitable situations and in some seasons is even abundant under favorable conditions. In a previous note on this species by the writer (*l. c.*), it is recorded as very common

at Ames on July 7, 1914. Many other specimens are at hand from Chariton, Decorah, Dubuque, Burlington, Centerville, Des Moines, Sac City, Forest City, Lake Okoboji, Iowa City and numerous other places in the state. In fact almost any field of timothy or blue grass will yield numbers of these bugs during the summer months. Sometimes also specimens are taken from red clover and some have been taken from mullein (*Verbascum thapsus* Linn.) and riverside grape (*Vitis vulpina* Linn.).

Adults are most common in July with also a good many in June and but few in August. Many half grown nymphs have been taken, mostly in late July and early August. Nymphs have not been taken earlier than July. Hibernating individuals have been found in March and April under rocks in out of the way places which have been permitted to grow up in weeds and grass during the summer. Now and then during the summer a specimen may be taken at street lights.

Neottiglossa sulcifrons Stål

1872. *Neottiglossa (Melanostoma) sulcifrons* Stål, Svensk. Vet. Handl., 10, no. 4, 18.
 1876. *Melanostoma sulcifrons* Uhler, Bull. U. S. Geol. Geogr. Surv., II, no. 5, 284.
 1904. *Neottiglossa sulcifrons* Van Duzee, Trans. Am. Ent. Soc., XXX, 50.
 1915. *Neottiglossa sulcifrons* Stoner, Ent. News, XXVI, 355.
 1917. *Neottiglossa sulcifrons* Stoner, Bull. Lab. Nat. Hist. S. U. I., VII, no. 3, 45.

General form elongate oval, smaller and more slender than *N. undata*. Color yellowish brown with blackish on median line of pronotum, anterior portion of pronotum and most of head; above, densely, finely punctured. Head black with a faint submarginal yellowish line on either side and a small, elongate yellowish spot on either side of median line near the base; entire surface thickly, coarsely, confluent punctured, the anterior half markedly deflexed and subdepressed, the margin near the eyes excavate, the margin before this sinuate; juga longer than the tylus and contiguous before it; tylus only slightly elevated. Antennae reddish brown, the second segment longer than third. Rostrum reddish brown, extending to hinder border of posterior coxae; apical segment darker. Bucculae black, densely punctate. Pronotum uniformly punctate, brownish, darker on anterior half either side of the middle; antero-lateral margins pale yellowish, the edges almost straight, black; a small pale yellowish spot in the faintly indicated transverse impression on either side of the median line. Humeri rounded, not prominent. Scutellum blackish with a broad yellowish brown area on either side of apical half; just within basal angles is a short, elongate, pale yellowish, calloused ruga parallel with lateral margin; punctuation of scutellum deep, uniform, gradually becoming finer towards apex which is broadly rounded. Hemelytra yellowish brown, regularly but

more sparsely punctate than scutellum, the basal half of costal margin pale yellowish and impunctate, the apex more distinctly sinuate than in *N. undata*; membrane whitish. Tergum black, densely punctured, with a narrow, pale yellowish, impunctate margin of uniform width. Venter black, deeply, coarsely, rather regularly punctured, the margin pale yellow, impunctate. Ventral plates of thorax black sometimes with faint yellowish maculations; more coarsely and irregularly punctate than venter. Legs yellowish with irregular brownish maculations; tarsal claws and apex of last tarsal segment infusate. Length, 4.0-4.5 mm. Width across pronotum, 2.0-3.0 mm.

This is our smallest representative of the subfamily Pentatominae and in addition to the characters above given it may be distinguished from its congener in our fauna by the fact that the ostiolar canal is prolonged outward in a fine though distinct wrinkle. In *N. undata* the wrinkle is merely a faint slender ridge extending outward for a short distance from the ostiolar opening.

Neottiglossa sulcifrons is typically a southern species, occurring more commonly in the southwest and has also been recorded from Nebraska. It was first recorded from Iowa by the writer in 1915 (*l. c.*). While apparently more common in southern Iowa several specimens are at hand from the northwestern part of the state. The localities represented are, Burlington, Chariton, Emmetsburg, Ft. Madison, Glenwood, Lake Okoboji, Shenandoah and Sioux City.

Half grown nymphs have been taken in late June and in July at Burlington, Ft. Madison and Glenwood. Hibernating individuals have not been discovered and practically all the specimens have been swept from sparsely growing blue grass and timothy. At Burlington on June 29, this insect was found in considerable numbers on the short blue grass growing in an orchard; and at Sioux City on July 20, several specimens were taken in a somewhat similar situation although at the latter place the orchard was not pastured as at Burlington and the long blue grass was intermingled with more or less timothy. More than fifty specimens are at hand from the localities mentioned above. This species affords a good illustration of the encroachment of a typical southern species upon our fauna.

Genus COSMOPEPLA Stål

1867. COSMOPEPLA Stål, Öfv. Vet. Akad. Förh., XXIV, 525.

This is another small genus containing less than ten species

all of which are found in the New World only. Five forms are recorded from North America; only one of these is of general distribution, the others being typical of the western and southwestern states. The important diagnostic characters of the genus may be summed up as follows:

From broadly obovate, beneath rather convex. Head strongly deflexed, slightly sinuate on either side before the eyes, the juga and tylus equal in length; bucculae elevated posteriorly. Rostrum extending behind posterior coxae, the first segment much longer than bucculae. Pronotum very convex, the lateral angles rounded. Scutellum broad and rounded at apex. Veins of membrane simple, longitudinal. Mesosternum slightly carinate. Ostiolar openings a little elevated but not continued in a sulcus. Tibiae terete, not sulcate.

Cosmopepla bimaculata Thomas

- 1865. *Cosmopepla bimaculata* Thomas, Trans. Ill. St. Ag. Soc., V. 455.
- 1798. *Cimez carnifex* Fabricius, Ent. Syst. Suppl., 535.
- 1834. *Eysarcoris carnifex* Hahn, Wanz. Ins., II, 117.
- 1837. *Pentatoma carnifex* Kirby, Rich. Faun. Bor. Am., IV, 275.
- 1872. *Cosmopepla carnifex* Stål, Svensk. Vet. Handl., 10, no. 4, 18.
- 1876. *Cosmopepla carnifex* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 284.
- 1893. *Cosmopepla carnifex* Montandon, Proc. U. S. Natl. Mus., XVI, 46.
- 1904. *Cosmopepla carnifex* Van Duzee, Trans. Am. Ent. Soc., XXX, 51.
- 1909. *Cosmopepla lintneriana* Kirkaldy, Cat. Hem. (Heterop.), I, 80.

General form broadly ovate, convex above and below. General color shining black, thickly punctured, marked with red or reddish yellow. Head black, strongly, regularly, closely punctate, more finely punctured on median line near base; sides of head in front of eyes slightly sinuate. Antennae shining black with dense, short white hairs, the apical segment much the longest. Rostrum black, shining. Pronotum shining black, densely, rather uniformly punctate except on disk which is crossed by a transverse and a longitudinal impunctate, calloused, reddish or reddish yellow line; the antero-lateral margins are also reddish to reddish yellow, impunctate and with the edges black. Scutellum shining black, punctured like pronotum, obtusely rounded at the extremity and with a reddish spot on either side near the apex. Hemelytra similarly punctured except on disk where the punctures are fewer; basal half with an impunctate, reddish costal margin; membrane white. Tergum black margined with reddish. Venter very convex, shining black, finely, rather regularly punctate, the margin narrowly, uniformly edged with reddish. Ventral plates of thorax more sparsely, coarsely punctured. Legs black, shining, the claws pale at base. Length, 5.0-7.0 mm. Width across pronotum, 3.0-4.25 mm.

This common and well known insect needs no special mention. It is subject to the usual variation in size and in the depth of color of the pale markings. Usually the antero-lateral pronotal margins are palest although in some specimens the color is as deep red as that on the other parts of the insect.

Many specimens are at hand from practically every locality visited. At some seasons this bug is often abundant and Lugger reports it as injuring raspberry and blackberry plants. Osborn (Proc. Ia. Acad. Sci., I, Pt. II, 121, 1892) records the species for Iowa and says, "Common, sometimes injurious on grape; also reported destructive on potato."

At Lake Okoboji in the summer of 1916 this was one of the most abundant species found in the vicinity of the Lakeside Laboratory during June and the first part of July. It was found commonly in wooded areas and along the edges of woods, especially in damp situations. On June 19, this species was swept in great numbers from black mustard (*Brassica nigra* Koch.) growing in a small cleared area in the woods south of the Laboratory. Over one hundred specimens were collected in a few strokes of the hand net. On June 22, the species was found in some numbers on one of the parsnips (*Thaspium aureum* Nutt.).

At Iowa City on July 9, I once found great numbers of these bugs on the blossoms of wild carrot (*Daucus carota* Linn.) growing in a small uncultivated area near a garden. At this time also several pairs were taken in copula. Specimens have also been taken upon mullein (*Verbascum thapsus* Linn.). In the hilly region about Decorah on August 10, in the woods and along the edges of the woods, we found the species very common; most of the specimens were taken from wild raspberry (*Rubus* sp.). By far the largest number of our specimens have been taken in July in which month the insect appears to reach its maximum of abundance; however, the bugs are often common until late in August. My latest seasonal record is November 5 when a single specimen was swept from dead weeds.

Other food plants recorded for *C. bimaculata* are figwort (*Scrophularia nodosa* Gray), crowfoot (*Ranunculus* sp.), currant, blackberry, mint and thistle.

Olsen (Bull. Brooklyn Ent. Soc., VIII, no. 4, 54, 1913) records the interesting observation that while conducting breeding experiments of *C. bimaculata* he found a male in the act of sucking dry the eggs deposited on the food plant, "moth mullein," by a female only a short time before.

Genus MENECLÉS Stål

1867. MENECLÉS Stål, Öf. Vet. Akad. Förh., XXIV, 527.

This peculiar genus was erected by Stål to include a single species, the *Pentatoma inserta* of Say. Since that time additional species have not been included in the genus in which, therefore, the type species remains the sole representative. It is widely distributed in both Canada and the United States. The principal diagnostic characters are as follows:

Body broadly ovate, more or less depressed. Head but slightly convex on dorsal surface, the sides sinuate near eyes. Rostrum reaching behind posterior coxae. Bucculae elevated into an angle at anterior extremity. Lateral margins of pronotum entire, explanate anteriorly; lateral angles rounded, not produced. Scutellum narrowed at apex. Apical margin of corium almost straight; veins of membrane irregularly anastomosing. Ostiolar opening without sulcus.

The only other Iowa genus of Pentatominae in which the veins of the membrane are reticulate is *Hymenarcys* but the present genus may be at once distinguished from it by the longer rostrum and the explanate margins of the pronotum.

Menecles insertus (Say) (PLATE V, FIGURE 11)

1831. *Pentatoma inserta* Say, Descr. Het. Hem., 6.

1859. *Pentatoma inserta* Say, Compl. Writ., I, 317.

1867. *Menecles insertus* Stål, Oefv. Vet. Akad. Förh., XXIV, 527.

1878. *Menecles insertus* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 375.

1904. *Menecles incertus* Van Duzee, Trans. Am. Ent. Soc., XXX, 52.

Body broadly oval, depressed, the margins much flattened. General color pale yellowish, rather uniformly, finely punctured with black. Head flattened, unarmed, set very deeply in pronotum, regularly punctate, a little more densely punctate at base; juga not longer than tylus, the margins broadly reflexed. Antennae reddish yellow, the apical segment and apical half of fourth segment blackish. Rostrum slender, pale yellowish, extending on to second visible segment; the two apical segments infusate. Pronotum rather uniformly punctured except antero-lateral margins and a narrow longitudinal median line; anterior margin deeply emarginate; lateral margins regular, broadly arcuated, the humeral angles included in the curve. Scutellum broad at base, narrowing distinctly towards apex; a narrow, longitudinal impunctate line continuous with the line on the pronotum extends backward about half the length of the scutellum and there becomes obsolete. Hemelytra considerably narrower than abdomen, the corium more densely and regularly punctate than the embolium; outer basal margin of embolium broadly reflexed; all the nervures impunctate; membrane hyaline. Tergum black, punctured, the margins less densely punctate, pale yellowish at the middle of the segments. Venter pale yellowish but so closely and finely punctate with blackish as to give an irregularly maculated appearance; disk of venter with a longitudinal series of large black spots; lateral margin blackish at the incisures. Ventral

thoracic plates coarsely but fairly regularly punctured with black; a large quadrate black spot on either side of the median line just behind anterior coxae. Legs pale yellow, thickly dotted with black and with irregular brownish maculations on the femora; apex of tibiae and apical tarsal segments brownish. Length, 12.0–14.0 mm. Width across pronotum, 6.0–7.5 mm.

The broadly ovate form, the explanate pronotal margins, the anastomosing venation of the wing membrane and the long, slender rostrum will at once serve to distinguish this peculiar pentatomid from any other in our fauna.

Of the twenty-three specimens at hand, all of which are from Iowa City, all but four have been taken in November. Not a single specimen has been taken in sweeping. One of the four specimens is a hibernating form taken May 11; a half grown nymph was taken September 24 and the other two specimens were taken October 24. Most of the specimens have been found under hickory or elm leaves in wooded or semi-wooded districts. In the east the species is said to be predaceous on the larvae of the gypsy moth (*Porthetria dispar* Linn.).

Osborn recorded *Meneclis insertus* as "rare" in Iowa with "Ames" as the only definite locality record.

Genus PRIONOSOMA Uhler

1863. PRIONOSOMA Uhler, Proc. Ent. Soc. Phila., II, 363.

This is a small genus erected by Uhler to contain a single North American form described by him from California. The chief diagnostic characters include the following:

Form elongate ovate. Body pilose, the pilosity longest on head and pronotum; dorsal surface with coarse, black, irregularly disposed punctures. Head long, narrow, the sides sinuate in front of eyes; juga rounded at apex, a little longer than tylus but not approaching before it. Rostrum short, very hairy, extending only a little behind midcoxae. Pronotum convex, broader than long, the lateral margins distinctly sinuate and with a prominent tubercle at the anterior angles; a prominent process slightly bent posteriorly at the lateral angles. Apex of corium emarginate at about the middle, the lateral angle distinct; veins of membrane irregularly furcate, sometimes anastomosing. Ostiolar canal scarcely continued in a sulcus. Sternum grooved to receive rostrum. Tibiae not sulcate, the anterior ones prismatic with a small spine on inner face.

In some of its characters this genus closely resembles *Trichopepla* Stål. Both have the pilosity but it is longer and coarser in *Prionosoma*. In the latter genus also the prominent processes

of the humeri are distinctive and the ostiolar canal is continued into only a very short sulcus, quite different in form from that in *Trichopepla*. In conjunction with the above characteristics, the presence of the sinuous, irregularly furcate and somewhat anastomosing venation of the wing membrane is worthy of mention.

Prionosoma podopioides Uhler (PLATE III, FIGURE 2, and PLATE VI, FIGURE 5)

1863. *Prionosoma podopioides* Uhler, Proc. Ent. Soc. Phila., II, 364.
1872. *Prionosoma podopioides* Stål, Svensk. Vet. Handl., 10, no. 4, 32.
1888. *Prionosoma villosum* Provancher, Faun. Can. Hém., 204.
1904. *Prionosoma podopioides* Van Duzee, Trans. Am. Ent. Soc., XXX, 52.
1916. *Prionosoma podopioides* Stoner, Ent. News, XXVII, 183.

Body elongate ovate, distinctly narrowed anteriorly and posteriorly. General color pale yellowish to brownish, rather closely and coarsely but irregularly punctured with black; each puncture contains a white hair. Entire body covered with short white hairs which are denser and longer on the head and pronotum. Head narrow, elongate, darker on either side of the pale median lobe which is distinctly raised and becomes suddenly broader between the eyes and extends thus to the base of the head; lateral lobes confluent punctate, a little longer than median lobe; entire head thickly covered with long white hairs. Antennae short, black, a little pale at incisures, the apical segment longest, all the segments with long, stiff white hairs. Rostrum short, extending just behind midcoxae, the two apical segments black, the basal segment shorter than the pale, high bucculae enclosing it. Pronotum rather regularly, coarsely punctate, the anterior half conspicuously pilose; antero-lateral margins entire, sinuate, a prominent tubercle at anterior angles and a prominent process somewhat curved posteriorly at the lateral angles just before the humeri which are rounded and a little elevated. Scutellum regularly, coarsely punctured with black, the punctures finer towards apex which is moderately narrowed; a broad Y-shaped ruga begins at the basal angles of the scutellum and continues for two-thirds the distance towards the apex where the stem of the Y becomes obsolete. Hemelytra narrower than abdomen, coarsely punctured, the costal margin impunctate, raised a little near base; apex of corium distinctly emarginate; membrane whitish, the nervures more or less sinuous and anastomosing to some extent; bordered with milky white. Tergum blackish, densely punctured, the outer posterior margin of each segment yellowish, the rest of connexivum fuscous. Venter pale yellowish to brownish, heavily punctate with blackish, each of the punctures bearing a fine white hair; the punctures aggregated somewhat along the sides below the spiracles to form a more or less distinct blackish longitudinal line; outer apical angles of segments expanded into tooth-like projections which thorax coarsely punctured and with long fine hairs. Legs yellowish, heavily give the edge of the abdomen a serrated appearance. Side pieces of

pubescent, dotted with fuscous, the apex of tibiae and all the tarsal segments black. Length, 8.5–11.0 mm. Width across pronotum, 5.0–6.0 mm.

The general coloration of this insect varies from a very pale yellow to almost a uniform fuscous. The punctuation of the scutellum and pronotum also varies considerably, some individuals possessing a much greater number of smooth areas than others.

This peculiar western form was first recorded from the state by the writer in 1916 (*l. c.*), when two specimens were listed. A female from Ft. Madison was collected June 30 and on October 30 a male was taken near Iowa City. The Ft. Madison specimen was swept from weeds growing in a sandy uncultivated area along the edge of woods. The Iowa City specimen was found under the leaves of a mullein plant growing in a sandy cultivated area.

These two specimens form the only available Iowa records. Zimmer records four examples from Nebraska and I have a number of specimens from Missouri. All the other records of which I am aware are from Colorado or farther west. Here again we have an illustration of the tendency on the part of one of the typical western forms to spread to the eastward where favorable environmental conditions may occur.

Genus *THYANTA* Stål

1862. *THYANTA* Stål, Svensk. Vet. Handl., 3, no. 6, 58.

This genus, containing about eighteen forms, is confined to the Nearctic and Neotropical regions. Nine forms are recorded from the United States while but a single species has, as yet, been recorded from Iowa although it seems likely that one or two more should occur within the limits of the state. The chief generic characters may be thus summarized:

Body obovate. Head ovate, somewhat flattened, slightly sinuate before eyes; juga not longer than tylus; sometimes the tylus slightly exceeds the juga. Antennal tubercles visible from above. Rostrum extending to or behind postcoxae, the first segment equal in length to the bucculae. Mesosternum carinate. Ostiolar openings continued laterally in a gradually disappearing wrinkle. Base of venter unarmed. Apex of corium with a distinct lateral angle. Tibiae above almost flattened or widely and weakly sulcate.

Thyanta custator (Fabricius)

1803. *Cimex custator* Fabricius, Syst. Rhyng., 164.
1851. *Pentatoma custator* Dallas, List Hem., I, 251.
1862. *Thyanta custator* Stål, Svensk. Vet. Handl., 3, no. 6, 58.
1872. *Thyanta custator* Stål, Svensk. Vet. Handl., 10, no. 4, 34.
1872. *Thyanta custator* Uhler, Rept. U. S. Geol. Surv., V, 399.
1876. *Thyanta custator* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 289.
1904. *Thyanta custator* Van Duzee, Trans. Am. Ent. Soc., XXX, 53.
1906. *Thyanta custator* Barber, Brooklyn Inst. Sci. Bull., I, 260.

Elongate ovate. General color pale green, closely, regularly punctured and more or less hairy. Head closely, uniformly punctate, flattened above, slightly sinuate in front of the eyes, the tylus a little raised and slightly longer than jugal. Antennae long, hairy, the two basal segments and basal half of third segment pale green; two apical segments and apical half of third segment deep reddish to fuscous; second segment longer than third. Rostrum extending to posterior margin of first visible ventral segment, the three basal segments greenish with black median line, the apical segment black; bucculae greenish, decreasing in height posteriorly and not quite enclosing basal rostral segment. Pronotum uniformly punctate, the lateral margins pale, slightly concavely arcuated, the edges a little roughened and setose; humeri usually obtuse, sometimes with a purplish red band extending across the pronotum between them; anteriorly, on either side of the median line is a smooth, yellowish, depressed lunate space sometimes enclosing a raised punctate area. Scutellum elongate, rather regularly punctate, the punctures arranged in more or less definite semi-transverse rows leaving fine rugae between; the punctures larger, deeper and denser along the margins; narrow apical portion attenuate, the extreme apex usually marked with pale or reddish. Hemelytra narrower than abdomen, regularly punctate and with a few small, smooth raised areas; costal margin at base pale or reddish; apical margin straight, the outer apical angle acute; membrane pale, longer than abdomen, a few black dots at base. Tergum pale green, the margin pale yellow to reddish, finely, confluent punctate and with, sometimes, a few black punctures anterior and posterior to the incisures. Venter pale yellow to greenish yellow, finely, rather regularly punctate, the space between the punctures finely, transversely aciculate; spiracles black. Side pieces of thorax coarsely, irregularly punctate. Ostiolar opening continuing laterally in a long groove which gradually becomes evanescent. Legs green, thickly furnished with short hairs, the apex of tibiae and the two apical tarsal segments infusate; front tibiae with a small spine on inner side at about the middle; all the tibiae broadly, shallowly sulcate. Genital segment of male broad, the lateral lobes somewhat flattened and divergent, broad apically, the sinus between them broad and scarcely notched in the middle. Length, 9.5-12.0 mm. Width across pronotum, 5.0-6.5 mm.

This is a very variable and no doubt plastic species which is widely distributed in North America. Some of the more char-

acteristic color and other variations may be mentioned here. The reddish purple band across the pronotum between the humeri may be very broad and conspicuous or entirely absent, with all phases of intergradation; the costal margin of the hemelytra at the base varies in the same way. Usually the connexivum is concolorous but sometimes it is alternated. In some specimens the connexivum is entirely concealed by the hemelytra. The membrane may be clear or dotted with fuscous. A pale, median longitudinal vitta may be present on the scutellum. The apex of the scutellum may or may not be pale or reddish. In some individuals the humeral angles are more or less spinose. The antero-lateral pronotal margins may vary from greenish to pale yellow or sanguineous. The general coloration may vary from dark green to pale green to very pale testaceous; individuals taken in autumn are likely to be yellowish or brownish; some specimens are whitish green; while some individuals may be quite hairy others have this character little developed. All the variations here discussed are exhibited in the more than seventy Iowa specimens before me.

Osborn listed this species as "Not common" in the state and added, "This appears to be nearly its eastern limit for this latitude." (Proc. Ia. Acad. Sci., I, Pt. II, 121, 1892.). We have taken the species in practically every locality visited and sometimes in considerable numbers. Curiously enough, not a single specimen was taken in the Lake Okoboji region during the summer of 1916 although the species occurs in northwestern Iowa for I have one specimen from Rock Rapids. However, in our experience, this bug has been much less common in the northern part of the state than in the southern part.

The height of abundance seems to be in July with August coming next. My earliest seasonal record is June 30 and the latest November 5 when a specimen was swept from dried grass in a sheltered place. On July 15 this species was found to be common near Des Moines in fields of timothy and red clover; both nymphs and adults were taken. Again, on July 20 at Chariton and on August 17 at Hampton numbers of this insect were taken in similar situations. At Iowa City we have usually found it in some numbers in any field of red clover especially if

the area was inclined to be a little moist due to insufficient drainage. Occasionally also, specimens are taken from weeds and grasses of various kinds. Forbes reports *T. custator* as feeding upon corn and wheat and Chittenden records it as injuring asparagus in South Carolina.

Genus MURGANTIA Stål

1862. MURGANTIA Stål, Stett. Ent. Zeit., XXIII, 105.

This small American genus containing about a half-dozen species is ordinarily confined to tropical and subtropical regions and but one form encroaches upon the Nearctic fauna. Diagnostic characters of the genus include the following:

Head strongly bent downward, only slightly convex on dorsal surface; median lobe longer than lateral lobes which have their margins reflexed and much swollen; sides of head weakly sinuate in front of eyes. Pronotum short, the anterior third suddenly bent downward, the lateral margins smooth. Ostiolar openings just anterior to lateral border of postcoxae, scarcely elevated and without a sulcus. Scutellum not reaching posteriorly as far as corium, the latter with a distinct outer apical angle. Tibiae strongly sulcate. Abdomen unarmed at base.

Murgantia histrionica (Hahn)

- 1834. *Strachia histrionica* Hahn, Wanz. Ins., II, 116, fig. 196.
- 1851. *Strachia histrionica* Dallas, List Hem., I, 263.
- 1853. *Eurydema histrionica* Herrich-Schaeffer, Wanz. Ins., Verz., 93.
- 1868. *Strachia histrionica* Glover, Rept. Ent. U. S. Dept. Agr. for 1867, 71.
- 1872. *Murgantia histrionica* Stål, Svensk. Vet. Handl., 10, no. 4, 37.
- 1876. *Murgantia histrionica* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 290, Pl. 19, fig. 9.
- 1877. *Murgantia histrionica* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 404.
- 1880. *Murgantia histrionica* Distant, B. C. A., Rhynch. Het., I, 71, Pl. 7, fig. 21.
- 1882. *Murgantia histrionica* Lintner, Rept. Ins. N. Y., I, 264, fig. 77.
- 1894. *Murgantia histrionica* Osborn, Proc. Ia. Acad. Sci., I, Pt. IV, 121.
- 1904. *Murgantia histrionica* Van Duzee, Trans. Am. Ent. Soc., XXX, 57.
- 1908. *Murgantia histrionica* Chittenden, Circ. 103, Bur. Ent. U. S. Dept. Agr., II, 85.
- 1913. *Murgantia histrionica* Stoner, Ent. News, XXIV, 132.

General form obovate, conspicuously marked in shining blue black, orange and whitish; sparsely, shallowly punctate. Head shining black, strongly deflexed, impunctate but with a few more or less distinct transverse rugae; tylus longer than the juga, the margins of the latter becoming more thickened and reflexed towards apex; a short, broad, yellowish white mark on either side of median line, a mark of the same color just before the eye and one on its posterior border. Antennae and rostrum black. Pronotum shining orange, very sparsely and irregularly punctate; a complete or more or less incomplete ring of black centered with orange

on each side; collum distinct, whitish; humeri rounded, not prominent. Scutellum black with a yellowish white spot at each antero-lateral angle, the tip and a central cross orange. Hemelytra a little narrower than abdomen, orange, crossed by two oblique, irregular black bands; membrane dusky, the nervures distinct, simple; clavus pale orange to yellowish white. Tergum black, the posterior one-fourth and most of the outer margin of the connexivum yellowish white; incisures black. Venter shining blue-black, impunctate, the abdominal segments at their margins bearing a row of triangular whitish spots; just within these at the anterior margin of each segment is a row of smaller spots of the same color, and again within these is another row of spots, the inner half of each spot yellowish white, the outer half orange; on the mid-ventral line is still another row of part-colored orange and white spots. Sternal plates shining blue black, all the coxal borders whitish anteriorly and in addition, the metasternum has two white spots and the mesosternum and prosternum one each; outer and posterior margins of mesosternum whitish; anterior and posterior margins of prosternum of the same color. Head beneath and bucculae marked with whitish. Legs fuscous marked with whitish, the tarsi and apical half of tibiae very hairy; inner face of anterior tibiae with a small sharp spine. Length, 9.5-12.0 mm. Width across pronotum, 5.75-6.5 mm.

Needless to say a good deal of variation in color pattern obtains in this conspicuously marked pentatomid which, on this latter account, has received among others, the names **Harlequin Bug** and **Calico Bug**. However, a discussion of the variations need not be included here since many more or less detailed descriptions of this abundant and injurious species are easily available.

This bug is typically southern in its distribution, having been first reported in the United States from Texas in 1864 when it destroyed great numbers of cultivated cruciferous plants. Since that time it has gradually increased its distribution to the northward along the Atlantic coast and up the Mississippi River valley. By 1870 it had reached Missouri; in 1876 it had reached Delaware, in 1891 it had reached Ohio, in 1892 it was recorded as injurious in New Jersey and in 1894 it was reported from New York. Specimens were reported from California in 1878 and the species had been recorded from Pueblo and Denver, Colorado, in 1882.

"The northward migration of the harlequin bug, although not without interruption, was apparently quite steady until recent years. Beginning with the year 1897, at which time the insect had reached its maximum as a pest in Maryland, Vir-

ginia, Delaware and adjoining states, climatic conditions adverse to its existence developed. These consisted of sudden changes of temperature, such as cold snaps followed by warm spells and the reverse during the winter. As a result, this bug, with several other forms of southern origin, was killed while hibernating and practically disappeared in the North until at the date of writing [1908], it is scarcely, if ever, reported as injurious from the District of Columbia northward." (Chittenden, *l. c.* 4.). Such wide and rapid dispersal is possible largely through the likelihood of fertile egg masses being carried on the leaves of the insects' food plants either by railroads or by boats.

The harlequin cabbage bug was first recorded from Iowa by the writer in 1913 (*l. c.*), when a male and a half grown nymph were taken in a truck patch near Iowa City on October 24. Although extended search has since been made in various parts of the state, particularly in the cabbage-growing districts, other specimens have not come to light. The cold winters of Iowa along with the characteristic and sudden changes in temperature will, in all probability, prevent this insect from obtaining much of a foothold in the state.

A great variety of food plants is recorded for this species. Various wild and cultivated crucifers are preferred and when these are not available almost any kind of truck crop is attacked. In the south thousands of dollars worth of damage are caused annually by the depredations of the harlequin bug. Various ornamental plants, citrus trees and many wild weeds and plants of various kinds are attacked.

Genus ACROSTERNUM Fieber

1861. ACROSTERNUM Fieber, Eur. Hem., 79 and 331.

This is a widely distributed genus containing about sixty species. Representatives are found in Nearctic, Neotropical, Palaearctic, Ethiopian, Oriental and Australian regions. For many years *Acrosternum* was awarded only subgeneric distinction under the genus *Nezara* but the differentials between them seem of sufficient importance to warrant generic rank to *Acrosternum*. Two representatives of the genus have been recorded for Iowa. The generic characters follow:

Color generally (in the North American forms, always) green. Head flattened above, rounded in front. First antennal segment not extending beyond anterior border of head. Pronotum somewhat deflexed on anterior half. Scutellum and pronotum concolorous, clear green. Base of abdomen armed with a short spine. Venter more or less carinate along median line. Metasternum slightly elevated. Ostiolar orifices continued into a long, gradually narrowing ridge which reaches nearly to antero-lateral angles of metapleuræ. Tibiæ sulcate.

Key to the species

Form short, oval; head short, cheeks exceeding tylus; sides of pronotum strongly arcuated; margins of abdomen concolorous with black points at the incisures; rostrum scarcely reaching midcoxae *pennsylvanicum*

Form more elongate; head longer; tylus and cheeks equal in length; margins of abdomen fulvous with black points at incisures; rostrum attaining midcoxae *hilare*

Acrosternum pennsylvanicum (De Geer) (PLATE VII, FIGURE 1)

- 1773. *Cimex viridis pennsylvanicus* De Geer, Mem., III, 330, Pl. 34, fig. 5.
- 1805. *Pentatoma pennsylvanica* Pal. Beauv., Ins. Afr. Amér., 186, Hém., Pl. 11, fig. 5.
- 1831. *Pentatoma abrupta* Say, Descr. Het. Hem., 6.
- 1851. *Rhaphigaster Parnisus* Dallas, List Hem., I, 279.
- 1859. *Pentatoma abrupta* Say, Compl. Writ., I, 317.
- 1872. *Nezara pennsylvanica* Stål, Svensk. Vet. Handl., 10, no. 4, 42.
- 1878. *Rhaphigaster pennsylvanicus* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 380.
- 1892. *Nezara pennsylvanica* Osborn, Proc. Ia. Acad. Sci., I, Pt. II, 121.
- 1904. *Nezara pennsylvanica* Van Duzee, Trans. Am. Ent. Soc., XXX, 58.

This apparently rare and locally distributed species resembles the following common Iowa representative of the genus, *A. hilare*, to a considerable degree and in order to avoid repetition, only the principal differential characters will be set forth here.

Acrosternum pennsylvanicum has a distinctly shorter and more broadly oval form than has *A. hilare*, but the uniform shining green color is common to both. In the present form the head is short and broad and the juga slightly exceed the tylus, thus leaving the apex of the head markedly incised; the rostrum is much shorter, scarcely reaching the midcoxae. The sides of the pronotum are strongly arcuated and are not so distinctly pale as in *A. hilare*. The margins of the abdomen are concolorous and have black points at the incisures. Length, 14.0 mm. Width across pronotum, 10.0 mm.

Osborn (*l. c.*), listed this form from Iowa without comment; further data on Iowa material are lacking. In addition to the Iowa record the species is reported for New York, New Jersey,

Massachusetts, Connecticut, Ohio, Illinois, Georgia and Montreal, Canada. I have one specimen from Virginia.

Acrosternum hilare (Say) (PLATE VII, FIGURE 2)

- 1831. *Pentatoma hilaris* Say, Descr. Het. Hem., 5.
- 1832. *Pentatoma hilaris* Say, Ins. Louis., 9.
- 1851. *Rhaphigaster Sarpinus* Dallas, List Hem., I, 276.
- 1859. *Pentatoma hilaris* Say, Compl. Writ., I, 304 and 316.
- 1868. *Rhaphigaster hilaris* Walker, Cat. Het., III, 566.
- 1872. *Nezara hilaris* Stål, Svensk. Vet. Handl., 10, no. 4, 42.
- 1878. *Nezara hilaris* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 380.
- 1904. *Nezara hilaris* Van Duzee, Trans. Am. Ent. Soc., XXX, 58.
- 1916. *Acrosternum hilaris* Van Duzee, Ck. List. Hem. Am. N. Mex., 8.
- 1917. *Nezara hilaris* Whitmarsh, Ohio Agr. Exp. Sta. Bull., 310, 517-552, 15 figs.

General form elongate oval. Color clear green, somewhat shining, rather closely and uniformly punctured. Margins of head, pronotum and abdomen yellowish white. Head uniformly punctate, the extreme edges blackish; tylus and juga equal in length or the tylus slightly exceeding juga. Ocelli red. Eyes fuscous. Antennae with second and third segments about equal but the third a little the longer; narrow apex of third segment and a wider apical portion of succeeding segments rufous or black, whitish at bases, the apical segment lighter at extreme apex. Rostrum attaining posterior coxae, pale green with black median line and apical portion of last segment. Pronotum somewhat deflexed anteriorly, the antero-lateral margins straight, the posterior angles rounded, not prominent. Scutellum long, broad, the apical portion distinctly narrowed, the basal margin with five usually distinct small yellowish calloused spots. Hemelytra a little narrower than abdomen, thus exposing the fulvous connexivum which is black at the incisures; costal margin of corium a little pale near base; membrane white with elongate dusky markings on some of the nervures near base. Venter pale whitish green, sparsely, regularly punctate at sides but the disk which is more or less distinctly carinate is smooth; stigmata yellowish; margins of venter pale yellowish with a black point at the posterior edge of each segment. Apex of genital segment of male trisinuate and with the outer apical angles acute. Ventral plates of thorax coarsely, irregularly punctured, the prostethus more densely and regularly punctate than the other plates. Ostiolar opening continued into a long, gradually disappearing sulcus. Legs green, scantily furnished with brownish hairs, the narrow apices of tarsal segments and tibiae infusate; apical half of tarsal claws infusate, base pale greenish yellow. Length, 13.0-19.0 mm. Width across pronotum, 7.5-10.0 mm.

This is our largest and usually our most common green pentatomid. It may be readily separated from its rare congener in our fauna by the characters given in the preceding key, and it may be separated from any other of our entirely green pentatomids by its size and its shiny green appearance. This bug enjoys a wide distribution, being found in Canada, Cuba, Pan-

ama and Brazil and throughout the United States. Osborn recorded it as common in Iowa and our collection contains many specimens collected in practically every locality visited.

By far the greatest number of our specimens have been taken in August. We have collected them at Hampton, Iowa City and Robinson on hazel (*Corylus americana* Walt.); at Ames and other places in the state we have found them on wild black cherry (*Prunus serotina* (Linn.) Reichenb.); and at Iowa City, Grinnell, Homestead and Lake Okoboji the species has often been found on wild grape (*Vitis* sp.), growing along the edges of woods and in more or less shaded and moist situations. On August 24, we found nymphs of this form common on basswood trees (*Tilia americana* Linn.) near Eldora and I have in my collection both nymphs and eggs taken on basswood, August 15.

Among some of the other food plants recorded for *A. hilare* are, cotton, sweet orange, trumpet creeper (*Tecoma radicans* (Linn.) Juss.), cowpeas and tomatoes (Kirkaldy) and it has been taken by Bueno on golden-rod. It is also reported to feed on the larvae of the cotton moth.

Genus BANASA Stål

1860. BANASA Stål, Svensk. Vet. Handl., 2, no. 7, 24.

This genus is Nearctic and Neotropical in its distribution and contains about twenty forms of which eight have been recorded from North America; three of these have been reported from Iowa. Although the genus is closely allied to the preceding and indeed, has been included in the old genus *Nezara* by some authors, the differentials separating the two are of as much consequence as those separating *Acrosternum* from *Nezara* and hence would seem to be valid. While these differences are more or less difficult to put into words, the general facies of the members of the genus *Banasa* is quite distinct from that of the members of the genus *Acrosternum* although not a great deal of actual structural difference prevails.

Body more or less elongate ovate. Head weakly sinuate before the eyes, the apex rounded, the lobes equal in length. Basal segment of antennae scarcely reaching apex of head; apical antennal segment twice as long as second. Rostrum reaching to postcoxae. Pronotum unarmed, humeri not produced. Mesosternum plain; metasternum a little elevated, emarginate posteriorly where it receives the short ventral spine.

Key to the species

Postero-lateral angles of abdominal segments slightly prominent,
acuminate

Second segment of antennae about one-half the length of
third; head broad anteriorly; ventral abdominal punctures
more numerous, darker.....*dimidiata*

Second segment of antennae a little shorter than third; head
narrowed anteriorly; ventral abdominal punctures few, pale
.....*calva*

Postero-lateral angles of abdominal segments not prominent,
obtuse; color clear green.....*euchlora*

Banasa dimidiata (Say) (PLATE III, FIGURE 3)

1831. *Pentatoma dimiata* Say, Descr. Het. Hem., 7.

1859. *Pentatoma dimidiata* Say, Lec. in Say, Compl. Writ., I, 318. (emended).

1876. *Banasa dimidiata* Uhler, U. S. Geol. Geogr. Surv., II, 291.

1904. *Banasa dimidiata* Van Duzee, Trans. Am. Ent. Soc., XXX, 60.

1909. *Banasa dimiata* Kirkaldy, Cat. Hem. (Heterop.), I, 122.

General form rather narrowly elongate ovate. Color dark reddish to olive brown, shining, the head and a little more than anterior half of pronotum greenish to yellowish. Head flattened above and uniformly, sparsely punctate, not narrowed much anteriorly, the sides a little sinuate in front of the eyes. Antennae rufous, the two basal segments and extreme base of third segment greenish yellow, the first and second segments about equal and not more than half as long as third. Rostrum slender, extending on to second visible ventral segment, greenish, with the apical portion of fourth segment blackish. Pronotum deflexed anteriorly, sparsely, irregularly punctate on anterior pale portion, more coarsely and closely punctured on dark basal part; antero-lateral margins straight, the humeri not prominent. Scutellum reddish brown, sparsely punctate, the tip whitish green and impunctate. Hemelytra coarsely, closely and shallowly punctate, the embolium green, the remainder reddish brown; membrane hyaline, the nervures simple. Tergum purplish black with tip rufous, sometimes entirely rufous, shining, the margin yellowish. Venter yellowish more or less suffused with greenish, smooth at middle but the sides with numerous brownish irregularly disposed punctures. Legs greenish, the tibiae and tarsi darkest; apices of tibiae and tarsal segments reddish brown. Length, 8.0–11.0 mm. Width across pronotum, 4.75–6.0 mm.

No other Iowa pentatomids have the color of the entire anterior half of the pronotum so sharply delimited from the color of the posterior half as this and the following species, and on this account they are readily referable to this genus. However, the combination of characters given in the key will usually suffice for distinguishing these two closely allied forms.

Banasa dimidiata is one of our most beautiful pentatomids although subject to some variation in color, size, punctuation and convexity of the pronotum. Some variation also obtains in the proportionate length of the second and third antennal segments.

In general, this is a common and widely distributed form but it appears to be rare in Iowa. Osborn recorded it from Ames with the note, "not common." But five Iowa specimens are at hand. Four are from Lake Okoboji; two were taken in June, one in July and another adult, apparently but recently molted, was collected August 22. All were taken in woodland from deciduous trees. A single specimen from Iowa City was taken November 6 from beneath dead elm leaves.

Banasa calva (Say)

- 1831. *Pentatoma calva* Say, Descr. Het. Hem., 7.
- 1851. *Rhaphigaster Catinus* Dallas, List Hem., I, 282.
- 1859. *Pentatoma calva* Say, Compl. Writ., I, 318.
- 1876. *Banasa calva* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 291.
- 1878. *Atomosira calva* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 379.
- 1904. *Banasa calva* Van Duzee, Trans. Am. Ent. Soc., XXX, 59.

Closely allied to the preceding but averaging a little larger and narrower posteriorly and with the colors a little paler. Body reddish brown, punctured and shining. Head distinctly narrowed anteriorly, the second segment of antennae proportionately longer than in *B. dimidiata*. Punctures on pronotum and hemelytra a little finer than in that species; usually a few calloused impunctate areas on corium. Venter pale, the punctures along the sides few and not strongly contrasted; outer apical angles of incisures marked with distinct black points.

This and the preceding species are very similar but the characters above mentioned in the diagnosis and key will usually serve to distinguish them. Osborn listed this form from Iowa and reported it as "not common." Thus far, we have not obtained specimens within the state. My material is from Washington, D. C., Wisconsin and Oregon. In general, this form seems to be less common than *B. dimidiata*.

Banasa euchlora Stål

- 1872. *Banasa euchlora* Stål, Svensk. Vet. Handl., 10, no. 4, 44.
- 1876. *Banasa euchlora* Uhler, Bull. U. S. Geol. Geogr. Surv., II, no. 5, 291.
- 1892. *Banasa euchlora* Osborn, Proc. Ia. Acad. Sci., I, Pt. II, 121.
- 1904. *Banasa euchlora* Van Duzee, Trans. Am. Ent. Soc., XXX, 61.

Elongate ovate, narrowed behind. General color pale green, shining, coarsely punctate, more or less marked with whitish calloused areas. Head green, finely but sparsely punctate, a whitish line in front of each eye, the

lobes equal in length; antennae long, two basal segments and most of third segment greenish, the fourth and fifth segments and apical portion of third segment reddish brown, the third segment a little longer than second. Rostrum extending between postcoxae. Pronotum unicolorous, coarsely, sparsely punctate, deflexed anteriorly, a more or less distinct longitudinal median line and a spot at each anterior apical angle whitish; antero-lateral margins straight; humeri rounded, a little swollen. Scutellum green, coarsely punctate, somewhat irregularly marked with whitish and with a large yellowish white calloused spot at each basal angle; apex yellowish white. Hemelytra more finely punctate but with an irregular, elongate calloused area on the disk; membrane white to hyaline, shining. Connexivum with a yellowish white spot at the middle of each segment. Venter rather sparsely but sharply punctate; green, with a median and two lateral white lines, the latter connected with the former by a finer whitish transverse line near the middle of each segment; outer margins of the segments with a yellowish white spot at the middle. Ventral thoracic plates green, the pro-, meso- and metastethus each with a large white spot on either side, the continuation forward of the lateral white lines of the abdomen; mesostethus with a large pale calloused spot on either side of median line at anterior margin. Legs green, the apex of tibiae and tarsal segments reddish brown. Length, 9.0-10.5 mm. Width across pronotum, 5.0-6.0 mm.

The shining pale green color with the distinct whitish calloused spot at each basal angle of the scutellum and the three longitudinal rows of white spots on the green venter will at once serve to distinguish this insect from its congeners as well as from any of our other green pentatomids. Osborn recorded a single specimen from Iowa but did not cite a definite locality. So far as I am able to determine, this still remains the only available record for the state. The ordinary distribution of this bug is much farther south than our latitude, the species having been recorded from Texas, South Carolina, Maryland, Florida, Indian Territory and Georgia. My specimens are from Louisiana, Alabama and New Mexico. Uhler (*l. c.*) records the occurrence of the species beneath the bark of cedar trees near Waco, Texas. Little is known of its habits.

Genus DENDROCORIS Bergroth

1877. ||LIOTROPIS Uhler, Bull. U. S. Geol. Geogr. Surv., III, 399.

1891. DENDROCORIS Bergroth, Rev. Ent., X, 228.

This is a small genus containing seven forms which are distributed mainly in southern and southwestern United States. The single Iowa representative is found throughout the United

States. The principal characters of the genus follow:

General form broadly oval. Head narrow, depressed, the lateral lobes flattened, longer than the tylus and meeting in front of it but the anterior margins are separated by a narrow cleft; basal segment of antennae not reaching apex of head; bucculae very narrow, a little shorter than head, sinuate at base. Pronotum very short and wide, gradually sloping towards anterior margins, the lateral angles wide, lobate. Scutellum broad, short, apex bluntly rounded. Posterior margin of corium obliquely rounded. Ostiolar opening continued into a long, gradually disappearing wrinkle.

Dendrocoris humeralis (Uhler)

1877. *Liotropis humeralis*, Uhler, Bull. U. S. Geol. Geogr. Surv., III, 400.

1891. *Dendrocoris humeralis* Bergroth, Rev. Ent., X, 229.

1904. *Liotropis humeralis* Van Duzee, Trans. Am. Ent. Soc., XXX, 62.

1906. *Dendrocoris humeralis* Barber, Brooklyn Inst. Sci. Bull., I, 262.

1909. *Dendrocoris humeralis* Kirkaldy, Cat. Hem. (Heterop.), I, 151.

General form broadly ovate, the lateral angles prominent. Color pale yellowish, tinged with orange, finely, rather remotely punctate with red and black. Head long, narrow, the lateral lobes lamellate, broadly rounded, longer than juga, sometimes meeting in front of it, sometimes with a deep fissure between their apices; punctuation of head confluent at base, more remote on juga which are narrowly margined with black; a short impunctate line on middle of tylus and an oval impunctate area just within each eye; tylus acutely tapering at tip; a short black line on under side of head in front of each eye. Antennae rufous, the basal segment stout, the remaining segments slender, the second segment shortest; tooth on antennal tubercle stout, black above. Rostrum pale yellowish, piceous at tip, reaching between midcoxae. Pronotum very short and wide, pale yellowish, punctured with red and black, the punctures more or less confluent near lateral margins; a black spot anteriorly each side of median line; humeri triangularly produced, tinged with rufous; antero-lateral margins pale, rather deeply sinuated, a small tooth at antero-lateral angles, the edge roughened a little behind it. Scutellum pale yellow, sharply punctate with brown, the punctures arranged in more or less uneven and transverse rows; apex wide, broadly rounded; a black spot on either side at narrowest point. Hemelytra wide, but not covering the connexivum; coarsely, remotely punctate with a few impunctate areas, the base and inner margin tinged with red; embolium rufous, irregularly punctate; membrane hyaline, somewhat bronzed. Connexivum orange with a black point at the outer posterior angle of each segment. Venter pale yellowish, remotely punctate with reddish. Sternal plates of thorax much more coarsely punctate. Legs pale yellowish, the tarsi and tibiae tinged with reddish. Ostiolar opening continued laterally in a gradually disappearing wrinkle. Posterior margin of anal segment of female with a short black line on either side. The posterior edge of the genital segment of the male is very deeply incised at the middle. Length, 6.5–8.5 mm. Width across pronotum, 4.5–5.25 mm.

This form bears some resemblance to *Euschistus tristigmus* but aside from its much smaller size it may be told at once from that form by the absence of black spots on the venter and the fact that the ostiolar opening is continued in a long wrinkle. As Uhler suggests (*l. c.*), it "forms a connecting link between the *Asopinae* and the group represented by the genus *Euschistus*."

Although this is the most abundant and widely distributed member of the genus it is seldom met with in Iowa. Osborn recorded the species as "Quite rare" in the state and gave one locality record, Ames. But three Iowa specimens are at hand. A male from Solon was collected August 15; and two females from Robinson were taken August 17 on hazel (*Corylus americana* Walt.). The species has also been found on hickory (*Carya* sp.), and oak (*Quercus* sp.). While it is found practically throughout the United States it apparently reaches its maximum of abundance in the western states; curiously enough it has not been listed from Nebraska.

Subfamily ASOPINAE (Spinola)

This is a rather well marked subfamily reaching its maximum of development in regard to both size and coloration in the Neotropical region. Forty-three forms are recorded from America north of Mexico and ten of these are represented in the Iowa fauna. Many of the members of the group are entirely or almost entirely predatory in habits and afford one of the natural checks upon the undue increase of noxious species of insects, so that the group as a whole is of considerable economic importance. Following are the principal characters of the subfamily:

Rostrum long, very thick, surpassing midcoxae; basal segment usually thickest; second segment longer than third. Bucculae very short, united posteriorly, covering only base of first segment of rostrum. Antennae of five segments, the basal segment very short, not reaching beyond anterior margin of head. Anterior tibiae with a small spine on inner surface. Ostiolar canal generally in the form of a long, more or less curved groove with sharply defined margins.

Key to the genera

Anterior femora armed with a spine or blunt tubercle near apex

Scutellum large, broad, extending almost or quite to tip of

abdomen; anterior tibiae distinctly expanded; frena not more than one-third the length of scutellum.....*Stiretrus*
 Scutellum moderate, narrowed towards apex; anterior tibiae very slightly enlarged near tip; frena one-half the length of scutellum*Perillus*

Anterior femora unarmed

Tylus usually shorter than juga leaving apex of head emarginate; length usually more than 13.0 mm.....*Apateticus*
 Tylus and juga equal in length, leaving apex of head truncate; length usually less than 13.0 mm.....*Podisus*

Genus STIRETRUS Laporte

1832. STIRETRUS Laporte de Castelnau, Essai. Classif. Syst. Hém., 75.

This genus is confined exclusively to America, most of the twenty-nine forms being found in the Chilean subregion although a few reach Mexico and five forms are recorded from North America. The species have a tendency to vary to a considerable extent and this has resulted, in many cases, in extensive synonymy. The principal generic characters are as follows:

Thorax twice as wide as long. Scutellum long and broad, reaching nearly to apex of abdomen which is armed with a spine at base. In our species the anterior tibiae are dilated and the frena are very short; anterior femora with a blunt spine or tubercle near tip.

But a single species of the genus has been recorded for Iowa by Professor Osborn and in all our collecting other specimens have not been discovered.

Stiretrus anchorago (Fabricius)

- 1775. *Cimex anchorago* Fabricius, Syst. Ent., 699.
- 1781. *Cimex anchorago* Fabricius, Spec. Ins., II, 341.
- 1794. *Cimex anchorago* Fabricius, Ent. Syst., IV, 86.
- 1803. *Tetyra anchorago* Fabricius, Syst. Rhyng., 137.
- 1837. *Pentatoma pulchellus* Westwood, Cat. Hope, I, 42.
- 1851. *Stiretrus anchorago* Dallas, List Hem., I, 80.
- 1870. *Stiretrus anchorago* Stål, Svensk. Vet. Handl., 9, no. 1, 24.
- 1876. *Stiretrus anchorago* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 281.
- 1904. *Stiretrus anchorago* Van Duzee, Trans. Am. Ent. Soc., XXX, 63.
- 1907. *Stiretrus anchorago* Schouteden, Gen. Ins., fasc. 52, 8.
- 1909. *Stiretrus anchorago* Kirkaldy, Cat. Hem. (Heterop.), I, 32.
- 1912. *Stiretrus anchorago inflata* Schumacher, Sitz.-Ber. Ges. natf. Freunde, 96.

Body ovate, convex, narrowing gradually posteriorly, sparsely, coarsely and irregularly punctate. Ground color blue black marked with orange. Head blue black with purplish reflections, deeply, coarsely punctate with ocelli and a median spot at posterior margin orange; sides nearly parallel;

juga a little longer than tylus. Rostrum reaching almost to posterior coxae; basal segment bluish, shining; remaining segments somewhat fuscous, paler at the incisures. Antennae blue black, the two apical segments fuscous, all the segments thickly clothed with fine yellowish hairs. Pronotum blue black, convex, coarsely, irregularly punctured; humeri rounded, sub-prominent; antero-lateral margins smooth, orange yellow, this yellow line expanding before the humeri, usually enclosing or almost enclosing a rounded blue black area; anterior margin just behind the eyes produced into small orange colored points; below blue black, coarsely, heavily punctured, the concave anterior margin orange yellow. Scutellum large, broadly rounded behind, extending almost to tip of abdomen, sparsely but more finely punctate than pronotum; ground color blue black with irregular area on basal fourth and apical lunule orange yellow punctured irregularly with fuscous. Hemelytra blue black with orange at apex of coriaceous portion; rather finely and more closely punctate than scutellum; membrane fuscous, somewhat surpassing the abdomen in length. Venter blue black, distinctly, irregularly punctured; the edges of the second, third, fourth and fifth visible ventral segments bordered with orange yellow enclosing a blue dot; posterior margin of sixth visible ventral segment also bordered with orange yellow; angles of segments blue; ventral spine and median half of segment following orange yellow. Legs shining blue black, the tibiae and tarsi with long yellowish hairs beneath; anterior femora armed with a long spine; claws yellowish tipped with fuscous; coxae fuscous, somewhat shining. On either side of the median line of the last three segments in the male is a slight depression thickly covered with long, reddish yellow hairs. Length, 8.0–11.0 mm. Width across pronotum, 5.0–7.0 mm.

This form is exceedingly variable in both size and coloration the latter ranging from almost a uniform yellow to almost a uniform violet; these differences have been made the basis for separation into varieties of which four have been recorded from North America. As a species it has been recorded from most of the southern states and from Pennsylvania, Massachusetts, New York and other northern states. Professor Osborn has indicated it as "common, not abundant," in Iowa but our collecting in the state has not thus far brought to light any specimens.

Professor Uhler states that in Maryland this form frequents the smooth sumach (*Rhus glabra* Linn.) and attacks the larvae of *Galeruca* sp. which feed on that plant. It has also been recorded as feeding on the larvae of *Papilio asterias* Fabr., *Lep-tinotarsa decemlineata* Say and *Epilachna borealis* Fabr.

Genus PERILLUS Stål

1862. PERILLUS Stål, Stett. Ent. Zeit., XXIII, 88.

Of the seven described forms comprising this Nearctic genus, all but one are found in North America. Three forms are recorded from Iowa but all are apparently quite rare in the state since only a very few specimens have been taken. Our representatives of the genus are somewhat variable as to coloration though all have a similar general facies. These forms are also, for the most part, predaceous and have been recorded as feeding upon various noxious insects; however, they are scarcely sufficiently abundant with us to be of material economic importance. The genus may be diagnosed as follows:

Basal segment of rostrum heavy. Lateral angles of pronotum unarmed. Scutellum moderate in size, triangular, not reaching much beyond base of membrane of hemelytra; frena extending to middle of scutellum. Anterior femora armed beneath with a spine or blunt tubercle; middle and posterior femora unarmed. Ventral abdominal spine reaching only to posterior coxae.

Key to the species

Anterior femora armed with a stout cylindrical spine; length, 8.0–11.5 mm.

Broader, less convex, pronotum shorter; antennae usually black with incisures and basal segment only pale or rufous

.....*bioculatus*

Narrower, convex; pronotum longer; antennae black with two basal segments and basal half of third segment pale or rufous

.....*circumcinctus*

Anterior femora armed with a low blunt tubercle; length 5.0–7.5 mm.*exaptus*

Perillus bioculatus (Fabricius) (PLATE III, FIGURE 4, and PLATE VII, FIGURE 3)

1775. *Cimex bioculatus* Fabricius, Syst. Ent., 715.

1872. *Perillus bioculatus* Stål, Svensk. Vet. Handl., 10, no. 4, 129.

1895. *Mineus bioculatus* Gillette and Baker, Hem. Colo., 12.

1904. *Perillus bioculatus* Van Duzee, Trans. Am. Ent. Soc., XXX, 66.

1907. *Perilloides bioculatus* Schouteden, Gen. Ins., fasc. 52, 37.

var. (b) *clauda* (Say)

1825. *Pentatoma clanda* Say, Journ. Acad. Nat. Sci. Phila., IV, 313.

1859. *Pentatoma clanda* Say, Compl. Writ., II, 240.

1876. *Perillus claudus* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 281.

1877. *Perillus claudus* Uhler, Bull. U. S. Geol. Geogr. Surv., III, 398.

1904. *Perillus bioculatus* Van Duzee, Trans. Am. Ent. Soc., XXX, 67.

1907. *Perilloides bioculatus* Schouteden, Gen. Ins., fasc. 52, 37.

Elongate, somewhat broadly ovate, apical one-third of abdomen tapering markedly posteriorly. General color black with the characteristic pale markings varying from orange to crimson. Head black, densely, irregularly punctured, less closely punctured at base; tylus and juga of equal length, the former with a prominent subapical concavity. Rostrum deep black, paler at the incisures, moderately heavy. Antennae black, incisures only pale. Pronotum pale rufous to deep crimson, with two large transverse black spots and posterior margin black; deeply, sparsely, irregularly punctured, the punctures finer and closer on posterior one-fourth; humeral angles bluntly angulate, not prominent. Scutellum sparsely punctate at base, much more finely and closely punctate on posterior one-half; black, except a broad, submarginal pale rufous to deep crimson vitta; the enclosed black area sometimes more or less bifid anteriorly, the black exterior to the vitta extending about three-fourths the length of the scutellum. Hemelytra black, with pale rufous to deep crimson at least on basal part of costal margin and sometimes extending along the whole of this margin; coriaceous portion blackish at tip; membrane fuscous, pale at margin. Venter pale rufous to crimson, deeply and rather regularly punctate except at middle; median line with two series of black spots, the spots of this series united on the last segment; on each side of the median series is another double series of black spots, the inner row of three large spots, the outer row of five smaller ones; the ultimate segment thus has but three spots. Genital area black or fuscous. Ventral spine long, slender, reaching to posterior coxae; tergum purplish, the connexivum pale rufous to crimson; side pieces of thorax black or fuscous. Legs black or fuscous; tibiae with a pale yellowish ring or dot near middle. Length, 8.0-11.5 mm. Width across pronotum, 5.5-7.0 mm.

The form above described is the typical *bioculatus* which includes Say's "variety b" and "variety c" of *Pentatoma clauda* and has the basal segment of the antennae black with the incisures only slightly paler. The other form, *clauda*, of this species is brown or piceous with the typical markings ivory white; the hemelytra are white with a black inner margin and a median triangular vitta. In all the specimens of this form which I have seen only the basal segment of the antennae and the incisures are pale; the head is also reddish brown, blackish at base; venter pale yellow and legs rufous. This is Say's typical *clauda* and includes also his "variety a."

Professor Osborn listed the form *Perillus claudus* Say from the state as a distinct species (Proc. Ia. Acad. Sci., I, pt. II, 121, 1892) and indicated that it occurred rarely in Iowa. It now is the generally accepted belief that *clauda* is but a variety of *bioculatus*. My collection contains but one specimen which can

be referred to this species, the typical *bioculatus*, and was taken at Clinton, April 20. A nymph, about one-third grown, taken at Iowa City, August 20, is apparently of the form *clauda* and an adult female taken in June at Sioux City should also be referred to this form.

This species shares the predaceous habits of its allies, and has been recorded by Howard as destroying the larvae of *Leptinotarsa decemlineata* Say; however, it is apparently not anywhere of sufficient abundance to be of great value in checking the increase of noxious insects.

Perillus circumcinctus Stål

- 1862. *Perillus circumcinctus* Stål, Stett. Ent. Zeit., XXIII, 89.
- 1872. *Perillus marginatus* Provancher, Nat. Can., IV, 74.
- 1878. *Perillus circumcinctus* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 370.
- 1880. *Perillus circumcinctus* Distant, B. C. A., Rhynch. Het., I, 34, Pl. 4, fig. 6.
- 1904. *Perillus circumcinctus* Van Duzee, Trans. Am. Ent. Soc., XXX, 67.
- 1909. *Perilloides circumcinctus* Kirkaldy, Cat. Hem. (Heterop.), I, 7.

This and the preceding form are extremely close together and I am unable to differentiate them with any degree of satisfaction owing to the prevailing tendency to vary. In the specimens I determine as *circumcinctus* however, the form is narrower and somewhat more convex, particularly above; the pronotum is also quite markedly longer than in *bioculatus*. In addition to this, the character of the antennae seems to hold fairly well in my specimens, those with the long pronotum and which are more convex having the antennae black with the first two segments and at least the basal portion of the third segment rufous. However, Zimmer in his "Pentatomidae of Nebraska," (Univ. Neb. Contrib. Dept. Ent., no. 4, 17, 1911) says that his specimens show every intergradation between typical *bioculatus* and *circumcinctus* in all the characters above mentioned and he is inclined to think that they are "but two extremes of an exceedingly variable form."

Professor Osborn records but a single specimen of this species from Sioux City and since no other records of specimens are at hand that record stands alone. Specimens from Minnesota and Illinois are in my collection.

Perillus exaptus (Say)

- 1825. *Pentatoma exapta* Say, Journ. Acad. Nat. Sci. Phila., IV, 313.
- 1837. *Pentatoma variegata* Kirby in Rich. Faun. Bor. Am., IV, 267.
- 1851. *Zicrona marginella* Dallas, List Hem., I, 109.

1859. *Pentatoma exapta* Say, Compl. Writ., II, 240.
1861. *Zicrona exapta* Uhler, Proc. Ent. Soc. Phila., I, 23.
1878. *Perillus exaptus* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 369.
1904. *Perillus exaptus* Van Duzee, Trans. Am. Ent. Soc., XXX, 65.
1907. *Perilloides exaptus* Schouteden, Gen. Ins., fasc. 52, 38, Pl. 3, fig. 2.

Elongate oval, not narrowing much behind. Color above deep blue black, somewhat shining, closely punctate; margins of pronotum, scutellum and hemelytra yellowish fulvous to crimson. Head black, thickly, deeply punctured, the anterior and sometimes the lateral margins pale; a pale spot in the median line at the posterior margin; sutures below pale. Eyes fuscous. Rostrum fuscous, moderately stout, reaching to posterior coxae. Antennae black, incisures and sometimes base of first segment pale. Pronotum rather closely and regularly punctate; yellowish fulvous with a broad transverse black band anteriorly and a narrower one on posterior margin; humeral angles not prominent. Scutellum black, except a broad submarginal yellowish fulvous vitta which is sparsely, finely punctured with fuscous; base punctured about like pronotum, the apical half much more finely and sparsely punctured. Hemelytra blue black with yellowish fulvous costal margin; embolium much more closely punctate than corium; membrane fuscous. Venter yellowish fulvous marked irregularly with black, rather regularly and densely punctured except on median line; connexivum entirely yellowish or fulvous, sometimes black margined with yellowish fulvous. Ventral spine very short, not reaching posterior coxae. Legs fuscous or black, irregularly punctured, all the tibiae banded with yellowish or fulvous; sometimes also the under sides of femora partake of this color; anterior femora furnished with a short blunt tubercle. Side pieces of thorax mostly black with the pale coxae standing out conspicuously. Length, 5.0–7.5 mm. Width across pronotum, 4.0–4.5 mm.

In the male, on either side of the median line of the fourth and fifth visible ventral segments is an elongate area thickly covered with decumbent yellowish brown hairs.

This is an exceedingly variable species which, in some form or another, is distributed from New England to Vancouver Island; in the east, south to New Jersey and in the west to Lower California. The variations which occur are mainly due to the relative amounts of the predominating colors present, black and yellowish fulvous, and to some extent to the disposition of these colors. The intensity of the pale color also varies from pale yellow to rich crimson and, indeed, the entire insect may vary from wholly black to crimson.

Professor Osborn's records of Little Rock and Ames remain the only two available for this species in Iowa.

Genus APATETICUS Dallas

1851. APATETICUS Dallas, List Hem., I, 105.

The members of this and the following closely allied genus are confined almost entirely to North, South and Central America and to the Antilles. As here delimited, the genus *Apateticus* contains forms of larger size than does the genus *Podisus*. The members of both genera are, in general, arboreal in habits and are almost entirely predaceous so that they make up a group of considerable economic importance destroying, in particular, the larvae of many noxious insects. The genus may be briefly diagnosed as follows:

Sides of head nearly parallel, apex emarginate, the lateral lobes longer than the tylus and often almost meeting in front. Eyes prominent, globose. Rostrum stout, not surpassing posterior coxae; second segment longest. Humeral angles rather prominent, usually obtuse; anterior part of lateral margins of pronotum denticulate. Abdomen with a spine of variable length at base. Anterior femora unarmed; anterior tibiae not dilated. Length usually over 13.0 mm.

In the North American fauna two subgenera are included in the present genus; one of these is represented in Iowa.

Subgenus APOECILUS Stål

1870. APOECILUS Stål, Svensk. Vet. Handl., 9, no. 1, 49.

Juga little longer than tylus, the apices converging a little but not contiguous; interior apical angles acute. Thorax with postero-lateral margins straight, posterior angles obtuse, scarcely produced. Apical angles of sixth ventral segment straight, not produced into spines. Frena extending beyond middle of scutellum.

Apateticus cynicus (Say) (PLATE III, FIGURE 5)

1831. *Pentatoma cynica* Say, Descr. Het. Hem., 3.

1851. *Arma grandis* Dallas, List Hem., I, 96.

1859. *Pentatoma cynica* Say, Compl. Writ., 312.

1867. *Podisus grandis* Stål, Öf. Vet. Ak. Förh., XXIV, 497.

1870. *Podisus (Apocilus) grandis* Stål, Svensk. Vet. Handl., 9, no. 1, 49.

1876. *Podisus cynicus* Uhler, Bull. U. S. Geol. Geogr. Surv., II, 282, Pl. XIX, fig. 18.

1897. *Podisus cynicus* Kirkland, Rept. Mass. Sta. Bd. Agr., XLV, 425, Pl. 1, fig. 7.

1904. *Podisus (Apocilus) cynicus* Van Duzee, Trans. Am. Ent. Soc., XXX, 70.

1907. *Apateticus cynicus* Schouteden, Gen. Ins., fasc. 52, 71, Pl. 5, fig. 8.

1909. *Apateticus (Apocilus) cynicus* Kirkaldy, Cat. Hem. (Heterop.), I, 22.

Elongate, robust, yellowish, thickly, irregularly punctured with red or fuscous. Head long, closely, irregularly punctate, the juga longer than tylus and approaching each other over its tip. Ocelli reddish yellow, very near posterior margin of head. Antennae yellowish, basal segment heavy, not reaching apex of head; second segment longest. Rostrum yellowish,

broad, stout, reaching to posterior coxae; second segment longest, first and fourth subequal, the latter blunt and entirely or almost entirely brown in color. Pronotum yellowish, thickly, irregularly punctured with red; humeral angles produced into rather sharp, stout spines somewhat flattened dorso-ventrally; antero-lateral pronotal margins sinuate, finely crenulate; pronotal callouses each bearing one or two small green punctate spots; a small spine on each side of anterior pronotal margin. Scutellum with a slight callus at basal angles and a narrow, median impunctate line near apex which extends over basal portion of membrane. Coriaceous portion of hemelytra yellowish or grayish; yellow, sometimes tinged with rufous, the punctures a little finer and more scattered than those of pronotum and scutellum; membrane bronze brown, surpassing tip of abdomen, the nervures a little darker. Venter pale clay yellow, impunctate on median line, the sides punctured with bright red; basal spine heavy, smooth, extending anteriorly to hind coxae; connexivum alternated with orange and black; median valve between basal plates in the female genital segment quadrangular. Legs pale clay yellow, the apices of tibiae and tarsi darker; femora faintly punctured with fuscous; claws tipped with fuscous. Length, 14.5-20.0 mm. Width across pronotum, 7.5-10.5 mm.

This is our largest pentatomid and has a tendency to vary somewhat in general coloration from grayish to yellowish; the coloration of the punctures varies from red to fuscous and the green markings on the thorax may be four and well marked or reduced to two very small punctured areas. The species is recorded by Professor Osborn as "not abundant in Iowa" and our collecting substantiates this statement. Specimens are at hand from Iowa City, Robinson and Lake Okoboji. It has been taken on wild cherry trees and at Lake Okoboji it was collected in clear spaces in or along the edges of woods on oak. At the latter place a nymph in the last instar was taken on July 4 and other nymphs representing various stages were taken before the middle of July. On one occasion while out collecting, two half grown nymphs were placed in a small tin box with two nymphs of *Brochymena quadripustulata* Fabr. of about the same size. Four days later the box was opened and the *Apateticus* nymphs were found to be alive and well while nothing was left of the *Brochymena* nymphs but empty skins. Apparently they had been destroyed by the *Apateticus* nymphs. *Apateticus cynicus* is reported as feeding upon a number of other insects and the list, together with something of the food habits in general is indicated by Kirkland, (*l. c.* 428).

Genus *PODISUS* Herrich-Schaeffer1853. *PODISUS* Herrich-Schaeffer, Wanz. Ins., IX, 296 and 337.

The differences between this and the preceding genus seem to be more apparent than real, the most striking being those of size and the form of the apex of the head. With very few exceptions all the forms contained in this genus are Nearctic and Neotropical and partake of the same economic value as do members of the genus *Apateticus*. The characters of the genus *Podisus* may be briefly summarized thus:

Sides of the head nearly parallel, the apex truncate, the juga and tylus equal in length, or rounded with the tylus slightly longer than juga. Eyes prominent. Second segment of antennae longer than fourth. Rostrum stout. Humeral angles usually prominent, often produced into spines; antero-lateral margins of pronotum crenulate or denticulate. Abdomen with a spine of variable length at base. Anterior femora unarmed; anterior tibiae simple. Length usually under 13.0 mm.

Two subgenera are recognized in the North American fauna.

Subgenus *PODISUS* Herrich-Schaeffer1853. *PODISUS* Herrich-Schaeffer, Wanz. Ins. IX, 296, 337.1860. *TELEPTA* Stål, Rio. Jan. Hem., I, 10.

Body oblong ovate. Head sinuate just before eyes, then parallel or somewhat contracted towards the apex which is broadly rounded or subtruncate. Thorax with lateral angles more prominent, rarely small and obtuse, often produced into strong acute spines. Base of abdomen armed with a spine of variable length.

Key to the species

Humeri entire, acute or spinose; membrane with dusky longitudinal vitta; form narrower behind middle

Ventral spine long, extending between posterior coxae; median ventral row of black spots small with the last one much larger; length, 10.0–14.0 mm.....*maculiventris*

Ventral spine short, not reaching to posterior coxae; median ventral row of black dots gradually becoming larger posteriorly; length, 7.0–12.0 mm.

Form broader; second segment of antennae about four times as long as first; color darker; length, 9.0–12.0 mm.

.....*serieventris*

Form narrow, depressed; second segment of antennae little more than three times as long as first; color reddish yellow; length, 7.0–10.0 mm.....*modestus*

Humeri blunt, rounded; membrane without a dusky longitudinal vitta; form broader than usual behind middle... *placidus*

Podisus maculiventris (Say) (PLATE I, FIGURE 6, PLATE III, FIGURE 6, PLATE IV, FIGURE 4, and PLATE VII, FIGURE 5)

- 1832. *Pentatoma maculiventris* Say, Ins. La., 11.
- 1851. *Arma spinosa* Dallas, List Hem., I, 98.
- 1859. *Arma pallens* Stål, Freg. Eugen. Resa, Ins., 222.
- 1870. *Podisus spinosus* Stål, Svensk. Vet. Handl., 9, no. 1, 51.
- 1897. *Podisus spinosus* Kirkland, Rept. Mass. Sta. Bd. Agr., XLV, 431, Pl. 1, fig. 4.
- 1899. *Pentatoma maculiventris* Say, Psyche, VIII, 307. [Reprint].
- 1904. *Podisus maculiventris* Van Duzee, Trans. Am. Ent. Soc., XXX, 71.
- 1907. *Apateticus pallens* Schouteden, Gen. Ins., fasc. 52, 72.
- 1909. *Apateticus maculiventris* Kirkaldy, Cat. Hem. (Heterop.), I, 19.

Elongate ovate; upper surface yellowish or grayish, thickly, irregularly punctured with reddish or fuscous. Head long, closely punctured with fuscous, especially the juga; sides nearly parallel, almost truncate in front; sometimes tylus a little longer than juga and the inner angles of the latter acute. Ocelli red, near posterior margin of head. Rostrum pale clay yellow, moderately stout, reaching posterior coxae, the apical segment reddish brown. Antennae slender, the basal segment very short, pale brown on outer surface; rest of segments rufous, the fourth and fifth sometimes tinged with brown. Pronotum with antero-lateral margins denticulate and narrowly bordered with yellow; humeral angles produced into long slender spines which are often tipped with fuscous or black; upper surface of pronotum irregularly punctured, the punctures more crowded along the antero-lateral margins and at outer ends of callosities. Scutellum similarly colored and punctured except towards apex which is less densely punctured and barely surpasses the base of the membrane. A more or less well defined, calloused, impunctate line extends from the anterior margin of the pronotum to tip of scutellum. Coriaceous portion of hemelytra colored like scutellum but more finely and sparsely punctate and usually tinged with red in the cuneal and embolial regions; membrane translucent, tinged with brownish and with a dusky longitudinal vitta at tip. Venter pale yellow, finely, rather sparsely punctate with red and brown; a row of small black spots on each margin at the angles of the segments; stigmata, a row of small spots on either side within these and a large oval spot on the apical segment black; anterior to this large oval spot some specimens show as many as three much smaller spots, one on each of the segments; some show two, some one, while others have only the large apical one; ventral spine long, slender, reaching between hind coxae. Connexivum pale orange with large greenish black marks at the incisures. Pleurae colored like venter, punctured with brown and with some small black spots one of which is always found at the tip of the ostiolar canal. Legs pale yellow to orange, finely punctate; femora usually with two black spots on under side near tip. Length, 10.0-14.0 mm. Width across pronotum, 6.0-8.0 mm.

This insect has something the appearance of *P. serieventris* but may be distinguished from that species by the larger size, the sinuation behind the slender pointed humeral angles, the long ventral spine and the proportionately large size of the posterior black spot of the median series as compared with the others of this series.

Podisus maculiventris is a common bug in most parts of the state. More than twenty-five localities are represented in our collection but in northwestern Iowa few specimens have been taken. It is very often swept from potato, red clover, timothy, sweet clover and hazel where it apparently feeds on the various other insects found on those plants. It has been mentioned many times and by numerous writers in connection with its propensity for feeding on the larvae of the Colorado potato beetle and it has been one of the important natural checks to the increase of that pest.

On one occasion an adult specimen of this species was brought in to the laboratory and placed in a chimney cage with a lepidopterous larva about $1\frac{1}{2}$ inches long. The bug soon attacked the larva and began sucking the body juices and even when it was disturbed so much as to be held by a pair of tweezers it would not let the larva go but continued the act of feeding. J. L. Horsfall has observed this pentatomid feeding on the tarnished plant bug (*Lygus pratensis* Linn.). Other insects which this bug preys upon are listed by Kirkland (*l. c.* 434). For a long time this insect was known as *Podisus spinosus* and many of the earlier references to it are under that name.

This pentatomid is a good flyer, its progress being swift and direct when once under way. I have many times taken it in flight, once at Independence from a bridge which crosses the Wapsipinicon river.

Apparently this is a double-brooded species since half grown nymphs have been taken in June and July and again towards the latter part of September. The young have rounded humeri and the antennae and tarsi each possess one less segment than is characteristic of these organs in the adult. During the early stages the nymphs are plant feeders for the most part although they also feed upon larvae of various kinds, but as they ap-

proach maturity they become entirely predaceous as are the adults. The eggs of this and allied species are parasitized by a number of small Hymenoptera.

Podisus serieiventris Uhler

1871. *Podisus serieiventris* Uhler, Proc. Bost. Soc. Nat. Hist., XIV, 94.
 1878. *Podisus serieiventris* Uhler, Proc. Bost. Soc. Nat. Hist., XIX, 370.
 1897. *Podisus serieiventris* Kirkland, Rept. Mass. Sta. Bd. Agr., XLV, 429, Pl. 1, figs. 2, 2a, 2b.
 1904. *Podisus serieiventris* Van Duzee, Trans. Am. Ent. Soc., XXX, 71.
 1907. *Apateticus serieiventris* Schouteden, Gen. Ins., fasc. 52, 72.

Pale yellow, thickly punctured with brown. Head truncate in front, densely punctured. Ocelli small. Rostrum moderate, pale yellow, apical segment brownish, darker at tip. Second antennal segment about four times as long as first. Pale antero-lateral margins of pronotum denticulate, the punctures aggregated to form a spot at each anterior and humeral angle; humeral angles acute but not spinose. Scutellum less densely punctate than pronotum, the punctures fewer and finer towards apex. Hemelytra colored similarly to pronotum and scutellum, the corium more densely punctured than embolium; membrane pale bronze brown with a longitudinal dusky vitta. Venter pale yellowish clouded with darker and sparsely, coarsely punctured; spots on median line becoming gradually larger posteriorly; each side of this occur two rows of small black or reddish spots, those forming the outer row being at the middle of the segments while those forming the inner row are at the anterior margins of the third to sixth visible ventral segments inclusive. Apex of the ostiolar canal black and a small black spot on each pleuron just outside the coxa. Connexivum alternated with pale orange and black. Legs rufous with two or three black spots towards apex. Length, 9.0–12.0 mm. Width across pronotum, 5.0–6.5 mm.

This form is close to *P. maculiventris* but smaller, the humeri are shorter, less produced and less acute and the ventral spine is shorter; in general, the coloration is also redder than in that species.

Professor Osborn listed *Podisus serieiventris* from Ames, but I can not with certainly attribute any of our Iowa specimens taken thus far to this species. It is not included in Zimmer's "Pentatomidae of Nebraska" but has been recorded from Montana, New York, New Hampshire and Vancouver Island. Kirkland says (*l. c.*) that it is "by far the most common representative of the genus" in Massachusetts. This form agrees with the others of the genus in its predaceous habits and the larvae upon which it is known to feed are listed by Kirkland.

Podisus modestus (Dallas) (PLATE VII, FIGURE 6)

1851. *Arma modesta* Dallas, List Hem., I, 101.
1867. *Rhaphigaster aggressor* Walker, Cat. Het., II, 359.
1880. *Podisus modestus* Distant, B. C. A., Rhynch. Het., I, 38, Pl. 4, fig. 4.
1897. *Podisus modestus* Kirkland, Rept. Mass. Sta. Bd. Agr., XLV, 419.
1904. *Podisus modestus* Van Duzee, Trans. Am. Ent. Soc., XXX, 71.
1907. *Apateticus modestus* Schouteden, Gen. Ins., fasc. 52, 72.

Form narrow, depressed. Upper surface pale yellow, more or less closely punctured with red. Rostrum stout, reaching to or between posterior coxae. Second antennal segment slender, comparatively short, little more than three times as long as first. Coriaceous portion of hemelytra tinged with reddish at junction with membrane, the latter bronze brown with a dusky vitta. Venter pale yellowish, shining, punctured with red; usually with a row of four small dots on the median line and another series on either side of the third, fourth, fifth and sixth visible ventral segments. Ventral spine very short. Legs pale yellow to orange. Length, 7.0–10.0 mm. Width across pronotum, 4.5–5.5 mm.

This is the smallest Iowa species of *Podisus* and is very similar to the light phase of *P. serieventris*. It may be separated from that species by the paler color, the shorter second segment of the antennae, the more depressed form, the paler tergum, the shorter ventral spine and the smaller size.

Professor Osborn recorded a single specimen of this species from Ames. My collection contains numerous specimens from Robinson only; they were collected in August on hazel.

Podisus placidus Uhler (PLATE VII, FIGURE 4)

1870. *Podisus placidus* Uhler, Amer. Ent. II, 203, fig. 124.
1870. *Arma placidum* Saunders, Can. Ent., II, 93, 94.
1897. *Podisus placidus* Kirkland, Can. Ent., XXIX, 115.
1897. *Podisus placidus* Kirkland, Rept. Mass. Sta. Bd. Agr., XLV, 416, Pl. 1, fig. 1.
1904. *Podisus placidus* Van Duzee, Trans. Am. Ent. Soc., XXX, 71.
1907. *Apateticus placidus* Schouteden, Gen. Ins., fasc. 52, 72.

Body elongate ovate, pale yellow, thickly punctured with red giving a mottled, reddish brown appearance. Head shorter than in the other species of the genus, the margins fuscous or black; juga not longer than, usually a little shorter than tylus. Rostrum pale yellow, moderately heavy, apical segment fuscous. Antennae reddish, second segment three times as long as first; a small black spot in front of each eye. Pronotum sparsely, irregularly punctate before the middle and more or less transversely wrinkled; more finely and densely punctate on posterior half; antero-lateral margins pale yellow, weakly denticulate anteriorly; humeri rounded, projecting only slightly. A black dot at tip of ostiolar canal. Scutellum much more finely punctate towards the apex; tip pale; a pale, more or less distinct calloused line extends from middle of anterior margin of pronotum

to apex of scutellum. Embolium densely punctate with red; corium less densely punctate; a yellowish brown smooth area at outer end of corium; membrane pale bronze, translucent, without longitudinal dusky vitta. Venter pale yellow, impunctate at middle, rather sparsely, irregularly punctate at sides; usually two rows of black points on either side of third, fourth, fifth and sixth visible ventral segments. Ventral spine long, attaining posterior coxae. Connexivum orange yellow with black dots at the incisures. Legs pale yellow, the tibiae darker. Length, 9.0–11.0 mm. Width across pronotum, 5.0–6.0 mm.

The somewhat ovate shape, mottled reddish brown color, straight antero-lateral margins of the pronotum, black margins of the head, plain membrane without longitudinal vitta and long ventral spine will serve to differentiate this species.

This insect is indicated by Professor Osborn as "rare" in the state. But two specimens are in my collection and these are from Iowa City and Robinson. The Robinson specimen was taken in August on hazel.

A CLASSIFIED LIST OF THE IOWA SCUTELLEROIDEA

Phalanx Pentatomiformes Reuter

Family Scutelleridae (Leach)

Subfamily Tetyrinae (Stål)

Genus *Homaemus* Dallas

aeneifrons (Say)

bijugis Uhler

proteus Stål

Subfamily Odontotarsinae (Stål)

Genus *Eurygaster* Laporte

alternatus (Say)

Family Cydnidae (Billberg)

Subfamily Thyreocorinae (Van Duzee)

Genus *Thyreocoris* Schrank

ater (Amyot and Serville)

nitiduloides (Wolff)

niger (Dallas)

lateralis (Fabricius)

pulicarius (Germar)

Subfamily Cydninae (Dallas)

Tribe Cydnini (Stål)

Genus *Cydnus* Fabricius

obliquus (Uhler)

Genus *Pangaeus* Stål

bilineatus (Say)

Genus *Geotomus* Mulsant and Rey

robustus (Uhler)

Genus *Amnestus* Dallas

spinifrons (Say)

pusillus Uhler

pallidus Zimmer

Tribe Sehirini (Stål)

Genus *Sehirus* Amyot and Serville

einctus (Palisot de Beauvois)

Family Pentatomidae (Leach)

Subfamily Graphosomatinae (Jakovlev)

Tribe Podopini (Dallas)

Genus Podops Laporte

Subgenus Amaurochrous Stål

cinctipes (Say)

parvulus Van Duzee

Subfamily Pentatominae Stål

Tribe Mecidiini (Distant)

Genus Mecidea Dallas

longula Stål

Tribe Halyini (Stål)

Genus Brochymena Amyot and Serville
arborea (Say)

quadripustulata (Fabricius)

carolinensis (Westwood)

Tribe Pentatomini (Stål)

Genus Peribalus Mulsant and Rey
abbreviatus (Uhler)

limbolarius Stål

piceus (Dallas)

Genus Trichopepla Stål
semivittata (Say)

atricornis Stål

Genus Rhytidolomia Stål
belfragei StålGenus Chlorochroa Stål
uhleri Stål

Genus Mormidea Amyot and Serville

Subgenus Melanochila Stål

lugens (Fabricius)

Genus Solubea Bergroth
pugnax (Fabricius)

Genus Euschistus Dallas

Subgenus Euschistus Dallas
servus (Say)

euschistoides (Vollenhoven)

tristigmus (Say)

var. pyrrhocerus (Herrich-Schaeffer)
variolarius (Palisot de Beauvois)
ictericus (Linnaeus)

Genus *Coenus* Dallas

delius (Say)

Genus *Hymenareys* Amyot and Serville

aequalis (Say)

nervosa (Say)

Genus *Neottiglossa* Kirby

Subgenus *Neottiglossa* Kirby

undata (Say)

Subgenus *Texas* Kirkaldy

sulcifrons Stål

Genus *Cosmopepla* Stål

bimaculata (Thomas)

Genus *Meneceles* Stål

insertus (Say)

Genus *Prionosoma* Uhler

podopioides Uhler

Genus *Thyanta* Stål

custator (Fabricius)

Genus *Murgantia* Stål

histrionica (Hahn)

Genus *Acrosternum* Fieber

pennsylvanicum (De Geer)

hilare (Say)

Genus *Banasa* Stål

dimidiata (Say)

calva (Say)

euchlora (Stål)

Genus *Dendrocoris* Bergroth

humeralis (Uhler)

Subfamily *Asopinae* (Spinola)

Genus *Stiretrus* Laporte

anchorago (Fabricius)

Genus *Perillus* Stål

bioculatus (Fabricius)

var. *clauda* (Say)

circumcinctus Stål

exaptus (Say)

Genus *Apateticus* Dallas

Subgenus *Apoecilus* Stål

cynicus (Say)
 Genus Podisus Herrich-Schaeffer
 Subgenus Podisus Herrich-Schaeffer
maculiventris (Say)
serieventris Uhler
modestus (Dallas)
placidus Uhler

SUMMARY

	Scutelleridae	Cydnidae	Pentatomidae
Families	3		
Subfamilies	7	2	2
Tribes	6		2
Genera	33	2	6
Subgenera	7		
Species	61	4	12
Subspecies	2		

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Plate III.

1. Front leg, *Euschistus variolarius*.
2. Front leg, *Prionosoma podopioides*.
3. Front leg, *Banasa dimidiata*.
4. Front leg, *Perillus bioculatus*.
5. Front leg, *Apateticus cynicus*.
6. Front leg, *Podisus maculiventris*.

PLATE III

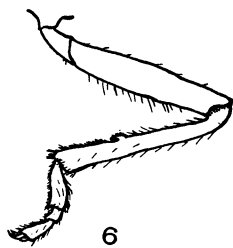
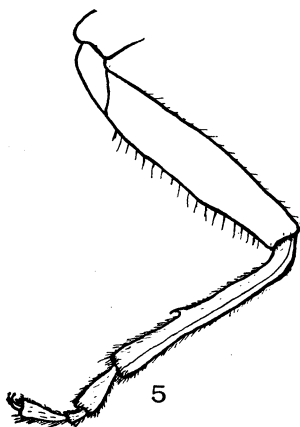
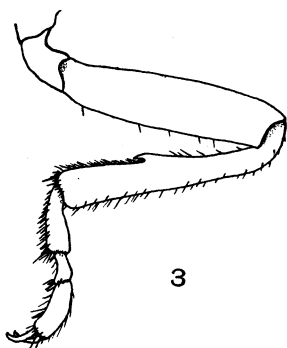
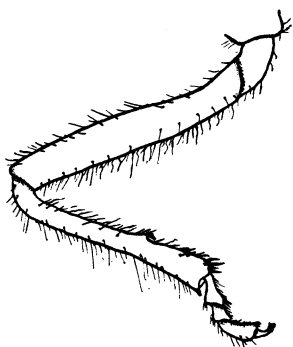
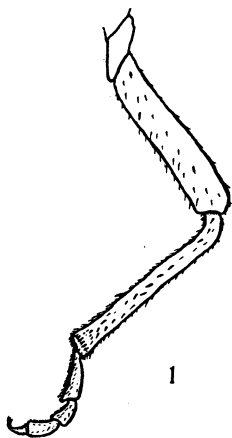
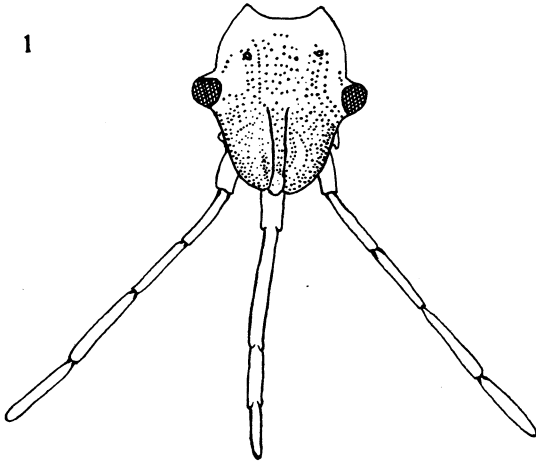


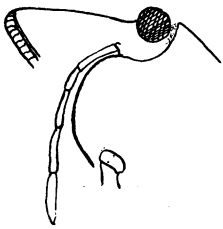
Plate IV.

1. Head of *Euschistus variolarius*.
2. Head and prostethus of *Homaemus bijugis*. (side view).
3. Head and prostethus of *Homaemus proteus*. (side view).
4. Head of *Podisus maculiventris*.

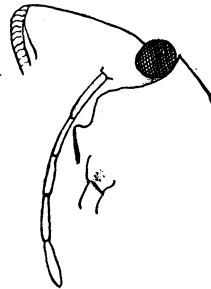
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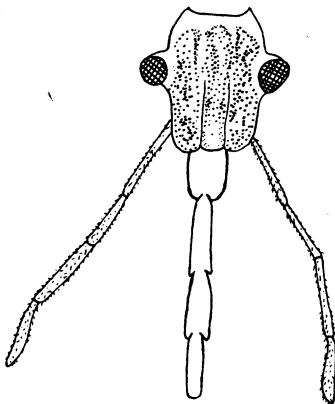
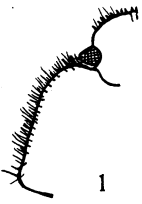


Plate V.

1. Left humeral angle, *Cydnus obliquus*.
2. Left humeral angle, *Geotomus robustus*.
3. Left humeral angle, *Amnestus spinifrons*.
4. Left humeral angle, *Schirus cinctus*.
5. Left humeral angle, *Podops cinctipes*.
6. Left humeral angle, *Podops parvulus*.
7. Left humeral angle, *Trichopepla semivittata*.
8. Left humeral angle, *Solubea pugnar*.
9. Left humeral angle, *Mecidea longula*.
10. Left humeral angle, *Coeus delius*.
11. Left humeral angle, *Meneles incertus*.

PLATE V



1



2



3



4



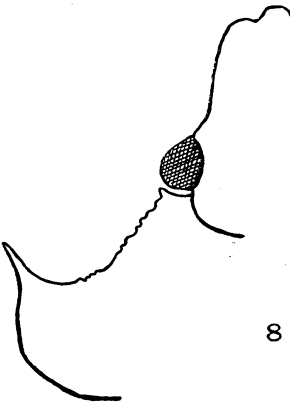
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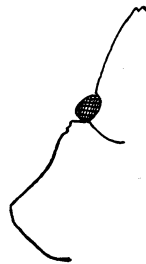
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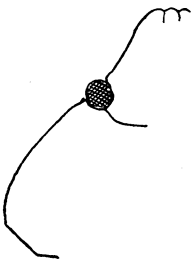
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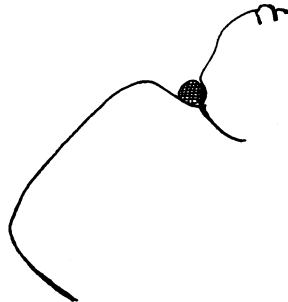
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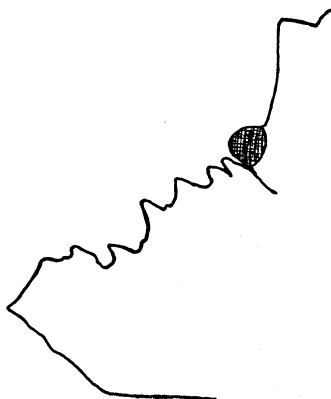


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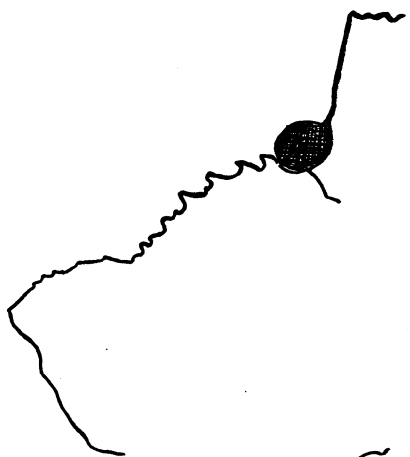


Plate VI.

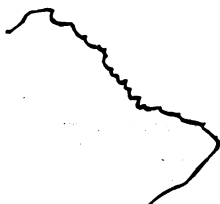
1. Left humeral angle, *Brochymena arborca*.
2. Left humeral angle, *Brochymena carolinensis*.
3. Right humeral angle, *Brochymena quadripustulata*.
4. Left humeral angle, *Euschistus variolarius*.
5. Left humeral angle, *Prionosoma podopioides*.
6. Left humeral angle, *Euschistus tristigmus* var. *pyrrhocerus*.
7. Left humeral angle, *Euschistus tristigmus*.



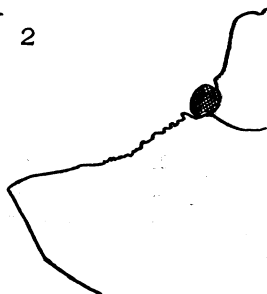
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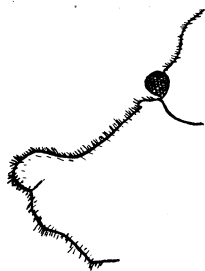
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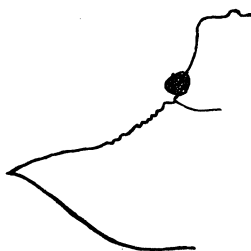
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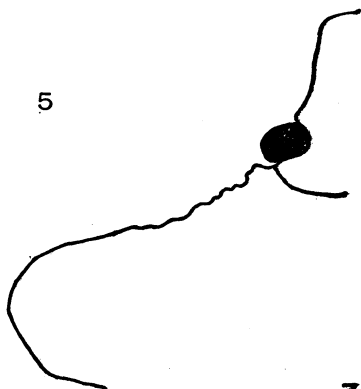
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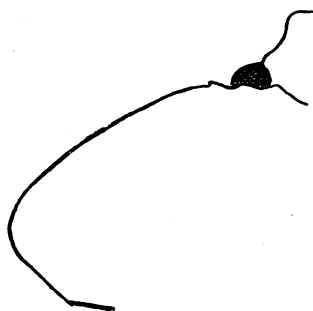


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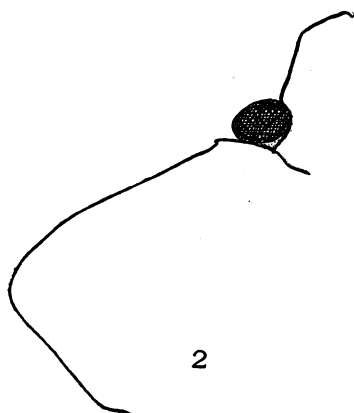
Plate VII.

1. Left humeral angle, *Acrosternum pennsylvanicum*.
2. Left humeral angle, *Acrosternum hilare*.
3. Left humeral angle, *Perillus bioculatus*.
4. Left humeral angle, *Podisus placidus*.
5. Left humeral angle, *Podisus maculiventris*.
6. Left humeral angle, *Podisus modestus*.

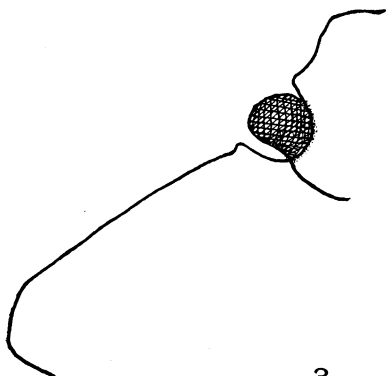
PLATE VII



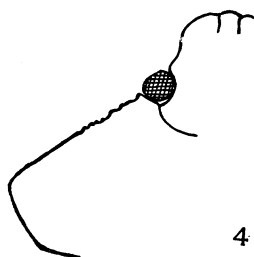
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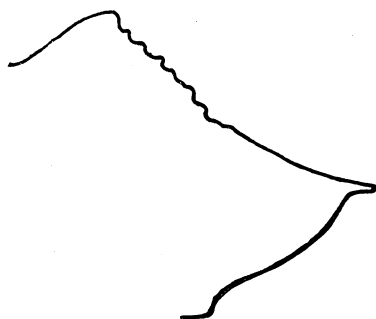
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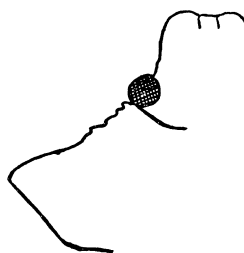
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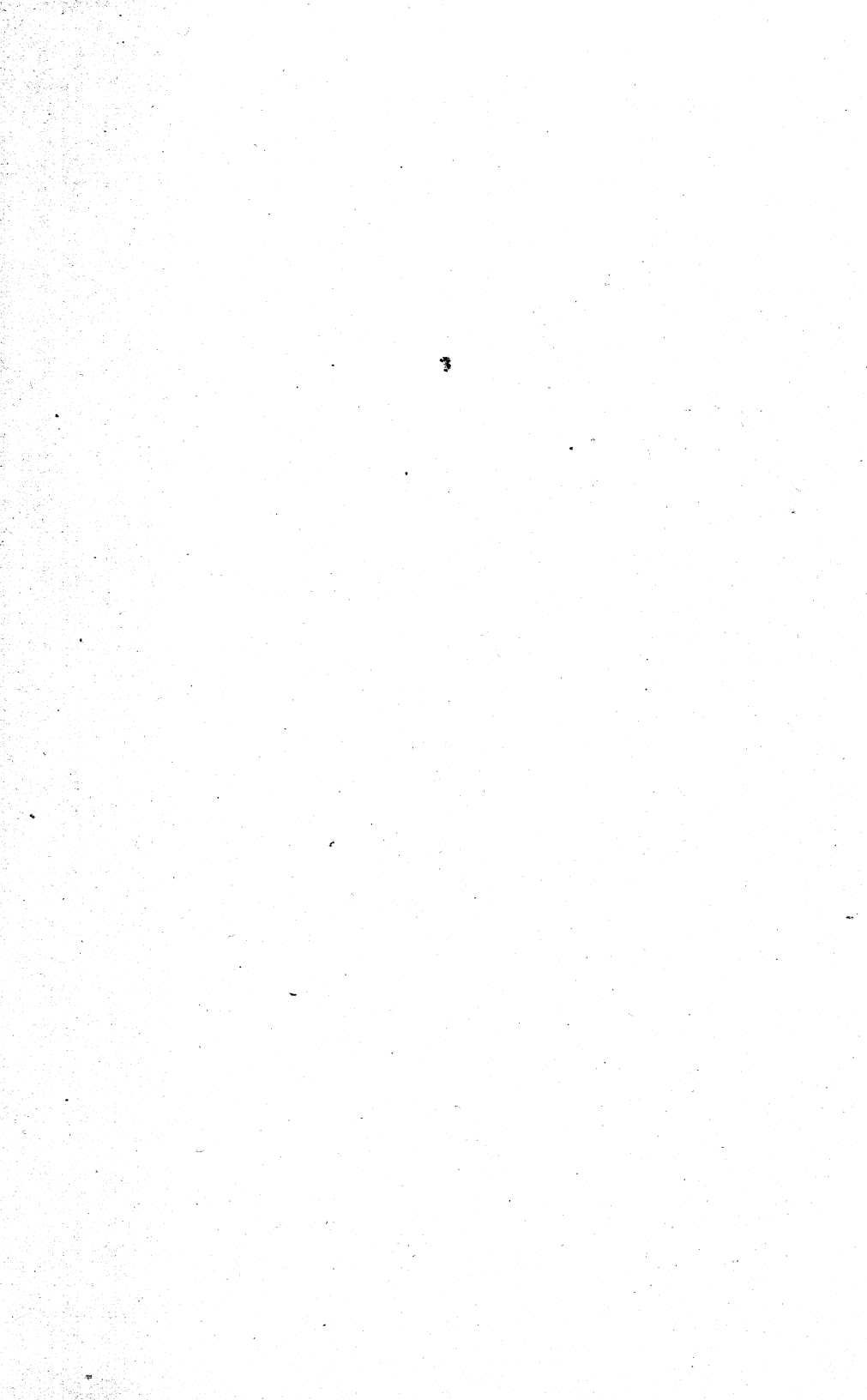


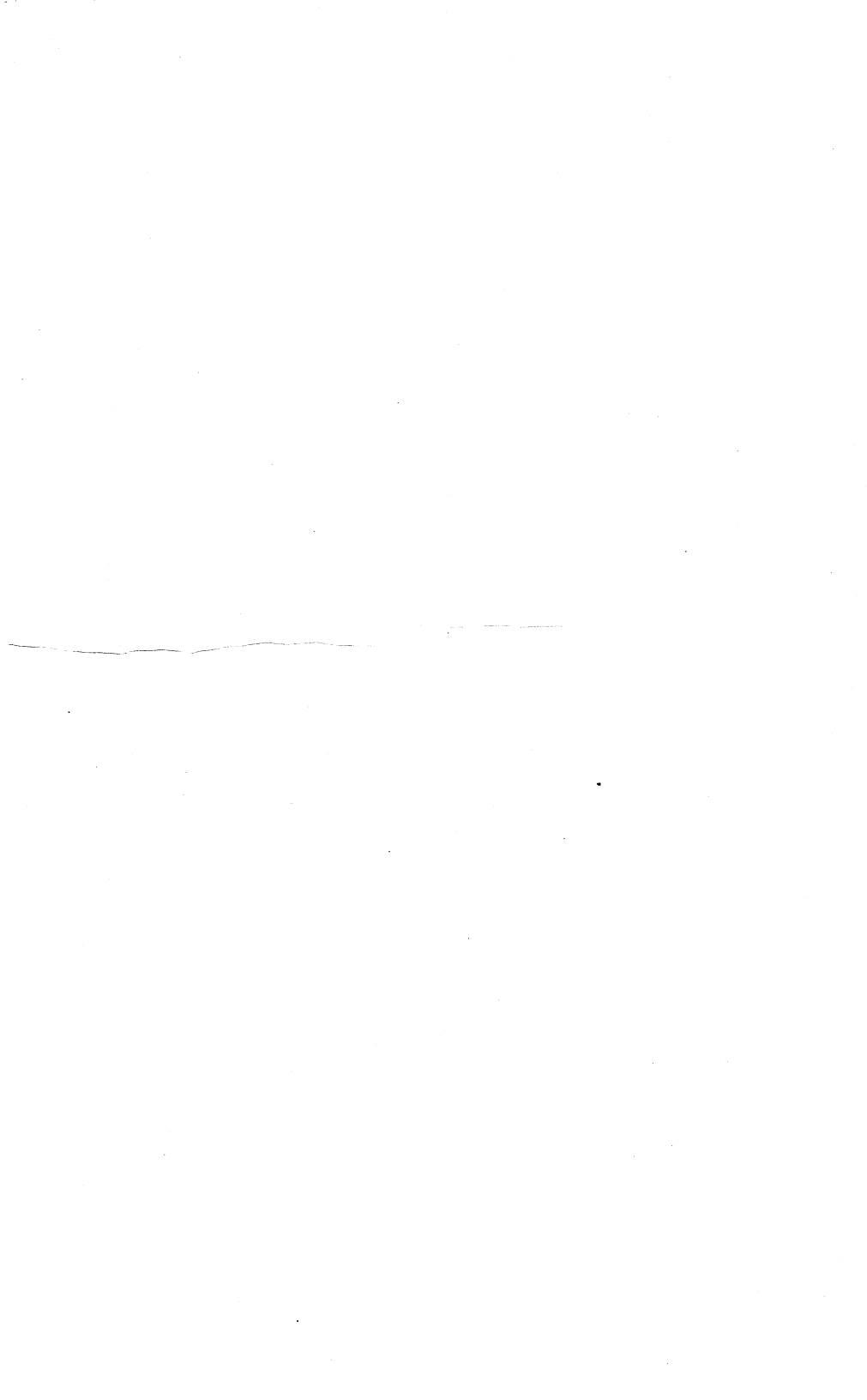
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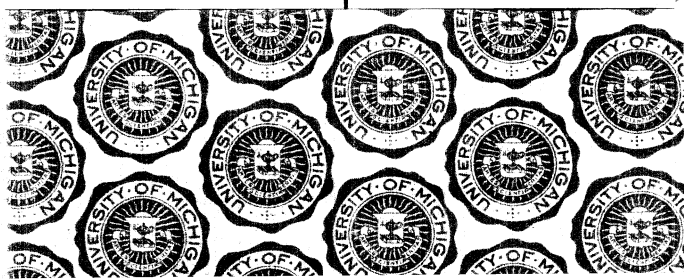




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